Causal Inference and the Millennium Development Goals (MDGs): Assessing Whether There Was an Acceleration in MDG Development Indicators Following the MDG Declaration

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1. August 2013

WORKING PAPER

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The views expressed in this research are those of the author and do not necessarily reflect the views of the United Nations or UNFPA.

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Abstract

Background: The Millennium Development Goals (MDGs) are a set of eight goals and corresponding indicators that were agreed to following the adoption of the United Nations Millennium Declaration in September 2000 by leaders of 189 countries. The goals state specific objectives for the world to accomplish by measuring progress in indicators during the time period from 1990 (ten years before the declaration) to 2015. While monitoring mechanisms have reported the progress towards achieving these goals, there has been little effort to evaluate whether there was a change in the development outcomes associated with the activities initiated by the MDGs. The dearth of evaluations applied to the MDGs may be associated with the lack of a true counterfactual or the challenges with the data quality. Our analysis focused on the questions of whether there was a statistically significant acceleration or deceleration (mathematically defined as an interrupted slope or intercept) for a particular indicator and, if there was one, whether that changepoint occurred before or after 2001. Accelerations occurring in 2000 or earlier cannot be causally associated with the MDG-related activities (since the acceleration predated the declaration) while accelerations after 2000 may logically be associated with MDG-related activities.

Method: We applied the standard program evaluation methodology of an interrupted time series to the country level yearly measurements of the MDG indicators as well as a set of control indicators that were not included in the set of MDG indicators (and were not likely to have been directly impacted by MDG-related activities). The modeling technique used was a multiple linear mixed model where we identified the optimal year of the changepoint in the outcome by examining years 1992 to 2008 for all datasets.

Analysis was performed separately for IDA-only countries (World Bank 2000 designation) as well as for a broader set of countries consisting of IDA, IBRD and Blend countries. The IDA (International Development Association) focuses on low income countries and the IBRD (International Bank for Reconstruction and Development) focuses on middle income countries. The primary data source for the analysis was the World Bank database where the analysis explicitly assumes that the reported data points are accurate. Reported results contain separate analyses for (1) including heavy influence countries and (2) excluding heavy influence countries; thus resulting in four sets of reported analyses as well as a detailed review of the individual MDG indicator.

Results: The general result was that there was no trend in statistically significant accelerations in the MDG indicators after 2000. Rather the results for all four sets of reported analysis were consistent in that about half of the MDG indicators exhibited no acceleration or deceleration during the time period from 1992 to 2008 and about one-third exhibited accelerations BEFORE 2001. Contrarily, nearly all of the control indicators had no change (neither acceleration nor deceleration) during the time period. It should be emphasized that the control indicators were identified based on data availability and other control indicators may exist that serve as more appropriate controls.

The only MDG indicator that had a statistically significant acceleration in progress in 2001 or after for all four datasets was Indicator 8D (Debt Service). MDG indicators 1B (GDP per person employed), 4A (Infant Mortality Rate), 4A (Under-five mortality rate), and 6A (HIV prevalence among population aged 15-24 years) all had statistically significant accelerations in 2000 or earlier for all four sets of analysis.

Discussion: The results may reflect some of the historical nature of the MGDs in that the Millennium Declaration represented a culmination of development agreements and goals that had been established over the preceding years. As such, many of the indicators selected to belong to the MDGs in 2000 had been previously identified in the global development agenda in the 1990s and campaigns to accelerate progress had been initiated before 2000. In fact, when the results of this study have been demonstrated at different United Nations forums, the reaction from seasoned development professionals has consistently been that of affirmation, where the audience generally has indicated that intuitively they would have expected the observed results given their knowledge of how the MDG indicators had been identified. Additionally, the results may be indicative of the impact of long-term broader economic trends where, for example, official development assistance (ODA) comprises only a very minor part of the global economy.

Conclusion: In order to ensure ongoing global support for development, especially as the global development community looks beyond 2015 to the post-MDG era, there needs to be careful communication regarding what the MDGs did and did not accomplish. Many of those who are not development professionals have been drawn into the global discussions due to the strong communications support for the Millennium Development Goals. As such, much of the general public expects that an acceleration in progress was triggered following the September 2000 Declaration and the associated increase in ODA. Contrarily, the data show clearly that the activities following the MDG Declaration did not provide an acceleration in most of the development goals. For the subset of MDG indicators that experienced an acceleration, the accelerations tended to occur before the MDG Declaration. This does not preclude the possibility that activities associated with the MDGs helped sustain accelerations that predated the September 2000 MDG Declaration or ward off decelerations. Additionally, this does not preclude the possibility that the MDGS provided an acceleration post-2000 in a subset of countries (i.e. sub-Saharan Africa or heavily ODA dependent countries) but it is important to note that this study examined the broadest question regarding the impact of the MDGs on the entire set of developing countries rather than a selected subset.

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Introduction

The Millennium Development Goals (MDGs) are a set of eight goals and corresponding indicators that were agreed to following the adoption of the United Nations Millennium Declaration in September 2000 by leaders of 189 countries. The goals state specific objectives for the world to accomplish by measuring progress in indicators during the time period from 1990 (ten years before the declaration) to 2015.

All 193 United Nations member states and at least 23 international organizations have agreed to achieve these goals by the year 2015. The goals (details may be seen in the United Nations website http://www.un.org/millenniumgoals/) are:

Goal 1: Eradicating extreme poverty and hunger,
Goal 2: Achieving universal primary education,
Goal 3: Promoting gender equality and empowering women,
Goal 4: Reducing child mortality rates,
Goal 5: Improving maternal health,
Goal 6: Combating HIV/AIDS, malaria, and other diseases,
Goal 7: Ensuring environmental sustainability, and
Goal 8: Developing a global partnership for development.

The goals have been controversial from the onset due to questions regarding the targets that were selected, the indicators chosen, notable omissions such as equality or agriculture, issues with the ability to accurately measure some indicators such as maternal mortality, malaria and tuberculosis and concerns about possible unintended consequences (such as a focus on primary enrollment potentially diminishing educational quality).

From a historical perspective, it is important to note that the declaration of the MDGs and the Millennium Summit did not represent the start of global movements towards issues of poverty, health, education and other key subjects. Rather, the Millennium Summit and corresponding declaration of the MDGs may be viewed as the culmination of many agreements and processes that had been occurring in the previous decade. The summit itself represented a means for the United Nations to solidify its role and position in the 21st century (United Nations 2000, We the Peoples) and reinvigorate the global community to refocus on development following a number of years of reduced Official Development Assistance (ODA) in the late 1990s. Many of the targets and indicators used in the MDGs were derived from indicators and targets established through various international conferences in the 1990's.

Global events and declarations that preceded the Millennium Summit that contributed to the identification of goals, targets and indicators include (but are not limited to):

1987:

- WHO launches the Global Program on AIDS.
- General Assembly resolves to mobilize the entire UN system in the worldwide struggle against AIDS and designates the WHO to lead the effort.

1990

- World Summit for Children: Heads of State and Government at the United Nations in New York City set 10-year goals for children's health, nutrition and education.

- World Declaration on Education for All adopted by the World Conference on Education For All, launching a global movement to provide basic education for all children, youth and adults.

1993:

- Declaration on the Elimination of Violence against Women (1993) was adopted, providing a framework for analysis and action at the national and international levels.
- International Congress and World Plan of Action on Education for Human Rights and Democracy (Montreal, Canada).

1994:

- International Conference on Population and Development (ICPD) Conference and Program of Action. Within the Program of Action, a large number of key areas of focus were identified that later became components of the Millennium Development Goals.

1995:

- The U.S. Food and Drug Administration (FDA) approved the first protease inhibitor initiating the era of highly active antiretroviral therapy (HAART).
- DOTS (Directly Observed Treatment, Short-course) Strategy launched.
- Declaration and Integrated Framework of Action on Education for Peace, Human Rights and Democracy, ICE (Geneva, Switzerland).

1996:

- UNAIDS begins operations bringing renewed focus and attention to HIV/AIDS;
- International AIDS Vaccine Initiative Exit Disclaimer (IAVI) forms to speed the search for an effective HIV vaccine.
- World Bank releases report on poverty titled "Poverty Reduction and the World Bank: Progress and Challenges in the 1990s"
- Heavily Indebted Poor Countries (HIPC) Program initiation by World Bank and IMF though initial uptake is low

1997:

- Highly active antiretroviral therapy (HAART) becomes the new standard of HIV care.
- Multilateral Initiative on Malaria founded to strengthen Africa's ability to spearhead new malaria approaches

1998:

- Roll Back Malaria Partnership (RBM) launched by WHO, UNICEF, UNDP and World Bank with goal of halving malaria incidence and mortality by 2010

1999:

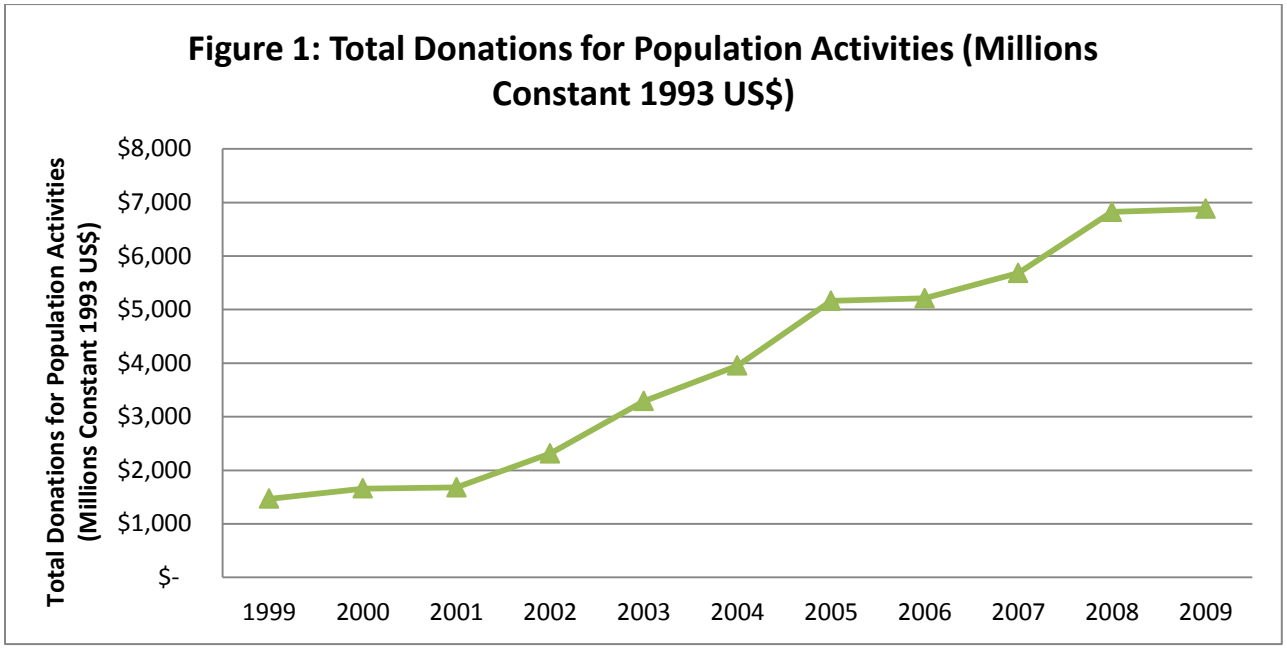
- World Bank publishes World Development Indicators 1999, warning that the new millennium could reverse the development gains recently made, and that new strategies are needed for the future.
- Operational Review and Appraisal of the Implementation of the International Conference on Population and Development (ICPD) Programme of Action raises concerns about overall progress.

2000:

- Heavily Indebted Poor Countries (HIPC) Program accelerated with 22 countries (18 in Africa) benefitting by end of year.

- Millennium Summit (September 2000) held in which the United Nations Millennium Declaration was ratified.

The Millennium Development goals succeeded at raising the global awareness of investing in development. As will be discussed later, there was a demonstrable increase in the amount of donor funding for development following the MDG Declaration. For example, as reported in the Financial Resource Flows for Population Activities (UNFPA, 2009), the donor funding for population activities in 2009 was nearly 5 times more than the amount provided in 1999.



Source: Financial Resource Flows for Population Activities (UNFPA, 2009)

Associated with the Millennium Development Goals was the enhanced investment in monitoring systems including support for census, vital registrations, surveys and analysis, all with the goal of better assessing progress towards achievement of the goals. Information regarding the progress towards achieving the MDGs is readily available on the internet at various UN-sponsored websites (see http://www.un.org/millenniumgoals/ and http://data.worldbank.org for example). These sources and other publications regularly report which indicators are "on track" or "off track", a reflection of whether or not those indicators are expected to achieve their targets by 2015. This monitoring of progress is important in assessing how countries are performing with respect to the MDGs but it is distinct from evaluation, the process of determining if the MDGs (declaration and resulting activities) causally impacted the outcomes of interest, the targets and indicators of development included in the MDGs.

To our knowledge, our study will be one of the first studies that specifically compare the rate of progress on the MDG indicators before and after the initiation of the MDG's in 2000, and the only one that conducts this analysis systematically for the entire set of MDG indicators using a rigorous quasi-experimental method. Rajaratnam et al (2010) assessed levels and trends in child mortality for 187 countries from 1970 to 2010 and found evidence of acceleration in rates of decline in child mortality –

31% of countries had rates of decline above the MDG 4 target rate of 4.4% per year from 1990-2000, and the figure increased to 34% from 2000-2010. However, it was not stated if the increase was statistically significant. Another study by You et al (2009) compared the rate of decline in under-five mortality rates in the 1990s with that in 2000-2008 and concluded that the rate has increased – although statistical significance was not examined. They also attributed the acceleration in progress to MDG activities such as improvements in coverage of bed nets and better delivery of vaccinations, although a formal link was not established. Moreover, those studies did not employ the methodologies of analyzing time series data to identify the time at which the program began accelerating but rather simply tried to argue about the result in aggregate. Beyond these studies, we did not find other studies that attempted to draw a causal link between the initiation of the MDGs and any acceleration or improvements in the MDG indicators.

Other studies surrounding the MDG indicators focus on analyzing and projecting trends in order to identify countries or regions that are on track to achieving the MDG targets in 2015 (Lozano et al., 2011; Sahn, David and Stifel, 2003; Leo, Benjamin and Ross, 2011; Economic Commission for Europe, 2006; Ritu and Rokx, 2004; Ram, Mohanty and Ram, 2009). It was generally found that regions such as Latin America/Caribbean, Asia and Central Europe are doing well, while regions such as Africa are below the achievement trajectory.

Many other studies focus on qualitative analysis of the MDG framework and make recommendations on how it could be altered to support the achievement of the MDGs, for example: improving data quality (Attaran, 2005; Murray, 2007); instituting a new MDG review process (Sumner, Andrew and Lawo, 2010); addressing issues on institutional quality and fiscal challenges (UNDP, 2010); improving country ownership (HuRiLINK, 2012); improving microfinance (Littlefield, Murduch and Hashemi, 2003); and redistributing or increasing aid (Gwatkin, 2002; Herfkens, Eveline and Bains; Radelet, 2004; World Bank, 2010).

This is an opportune time to examine the question of whether or not the MDGs stimulated an acceleration in key indicators of global development. 2013 marks a critical point in development work – growth in the global economy is slowing, donor funding is being challenged and the lack of progress in development is causing concern. Amid these challenges, UN Task Teams are exploring the establishment of new development goals that are inclusive of other aspects of development neglected by the Millennium Development Goals (MDG), activities grouped together as the "Post-2015 Planning". These new targets will stimulate interest and investment in specific areas related to development but overhead floats the critical question of **whether these MDG-related development activities have had a significant impact on development progress since 2000?**

This is a difficult task to address given the fact that there is no true counterfactual. That is, there is no alternative world in which countries did not declare the MDGs with which to compare. Moreover the near-universality of the declaration means that there are no hold-out samples to use as a comparison. Another challenge in this analysis is related to the data quality itself, which has improved substantially since 2000 but certainly had substantial limitations before 2000 and, in some indicators, continues to have limitations to this day.

To draw a causal inference regarding the relationship between the MDG-related activity and development progress, one can think of the conditions identified by John Stuart Mill for causal inference: (1) that the cause precedes the effect, (2) that the cause is related to the effect and (3) that there are no other plausible explanations other than the cause. In determining whether there is a causal relationship between the MDG Declaration and resulting activities, the analysis is complicated by the facts that virtually the entire world was involved in the declaration (so there is no true control population that was not impacted by the MDG Declaration and resulting activities) and that the goals were declared 40% of the way into the time period stated for the target (1990 to 2015).

In order to test the hypothesis of whether or not there was an acceleration in development indicators associated with the MDGs, we invoked the quasi-experimental program evaluation method of interrupted time series and applied this to the MDG identified indicators. The math technique used for this analysis, described in more detail later, is a multiple linear mixed model. This mathematical functional form is appropriate for data of this structure in that it accounts for the correlations among repeated observations from the same country while the assumptions of simpler approaches such as multiple linear regression models are violated under these circumstances.

The interrupted time series method allows us to identify if there was an acceleration (interrupted slope) for the time series measurements. For datasets where there was an acceleration, the year of the interruption was compared with the timing of the MDG activity. As a secondary measure, we also explored if there was a step change in the development indicators (interrupted intercept) though this is not generally considered likely given the fact that global development programs scale up over time and don't usually have a ramp-up of less than one year. Logically, if there is no measurable acceleration or step-up (no interrupted slope or interrupted intercept) between 1990 and 2010 in the MDG indicators, then we cannot say that the development activities during that time period accelerated development progress for those specific MDG indicators. If there was an acceleration in development outcomes that was associated with MDG-related activity, then, in order for it to be causally-related to the MDG Declaration, the acceleration had to start in 2001 or later since the declaration was in September 2000. This is a consequence of assumption (1) above for causal inference. Accelerations that occur before the MDG Declaration (before 2000) cannot be causally linked to the MDGs (a breakdown in assumption (1) above) but may be causally linked to the activities that preceded the MDGs.

Additionally, a set of control time series datasets were selected by identifying data series that were important to development but not included in the MDGs and would not likely have been directly impacted by the MDGs. The control set of indicators presents an additional test of the causal relationship of the MDGs to development. Logically, it is not absolutely necessary to have control indicators since in an interrupted time series analysis, the pre-declaration time period acts as the control for the post-index time period for the MDG indicators. That is to say, one could describe the MDGs a pre-post design with multiple pre and post measurements and no control.

Nonetheless, if the control set of indicators experienced an acceleration soon after the MDG activity (2001 or later) this would indicate that the controls were either impacted by the MDGs or raise questions regarding whether accelerations in the MDG indicators identified post-2000 are truly causally related to the MDGs. If the controls experienced the same pattern of accelerations or decelerations as

the MDGs then it would suggest a breakdown in assumption (3) above for causal inference. That is, if both the MDG-related indicators and indicators that are not clearly related to the MDGs experience the same patterns of acceleration or deceleration then one should look for other plausible explanations for the acceleration beyond the MDG-related activity.

Data Sources

Data Sources

While the primary data source was the World Bank Database (http://data.worldbank.org/), data was also extracted from the UNICEF and the World Health Organization (WHO) databases to ensure standardization across all countries. Our analysis focuses on developing countries, which we define as countries classified into the World Bank's IDA, IBRD and Blend[1] lending categories in 2000[2]. Countries in these categories have been identified by the World Bank to be in need of developmental aid, with low income IDA countries displaying the greatest need. Data was analyzed for two groups of developing countries, where group 1 consisted of the IDA, IBRD and Blend countries (low and middle income) while group 2 consisted of only the IDA countries (low income only countries).

Data was extracted between September 2012 and November 2012 and reflects the latest data available at the time of data extraction.

Selection Criteria

We defined the following objective criteria for selection of indicators:

1. Data availability: annual data should be publicly available for the time period 1990-2010 so that the analysis could be readily replicated by other researchers.
2. Data volume: annual data should be available for at least 50 countries in the IDA, IBRD and Blend categories for at least 10 consecutive time points from 1990-2010 where the time period begins before 1998.

MDG Indicators

44 MDG indicators were listed in the World Bank database. Of these, 19 were found to match the criteria above. Appendix A contains descriptions of the 25 indicators that did not match our selection criteria. We replaced World Bank statistics for the under-five mortality rate and the infant mortality rate with the most recent 2012 data from the UNICEF Child Mortality Estimates (CME) database.[3]

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[1] IDA countries are those that had a per capita income in 2011 of less than $1,195 and lack the financial ability to borrow from IBRD. IDA loans are deeply concessional—interest-free loans and grants for programs aimed at boosting economic growth and improving living conditions. IBRD loans are nonconcessional. Blend countries are eligible for IDA loans because of their low per capita incomes but are also eligible for IBRD loans because they are financially creditworthy. For more information see: http://data.worldbank.org/about/country-classifications

[2] Lending categories in 2000 were selected instead of those in more recent years to avoid selection bias – since countries that did well economically and developmentally were more likely to graduate from the IDA, IBRD and Blend lending categories, thus skewing the sample of IDA, IBRD and Blend countries in more recent years towards countries that showed slower progress in development.

[3] Available at: http://www.childmortality.org/

Table 1 describes the complete list of MDG indicators in our study:

Table 1: MDG Indicators

MDG Target	Indicator Code	Definition	Number of Countries	Data Availability	Data Source
1B	Productivity	GDP per person employed (measured in constant $1990 USD)	Total (IDA+IBRD+ Blend): 84 IDA: 25	1990-2010	World Bank Database
IB	Employment to population	Ratio of total employed to total population	Total: 129 IDA: 54	1991-2010	World Bank Database
3A	Women in parliament	Proportion of seats held by women in national parliaments (% female in a single or lower chamber)	Total: 69 IDA: 22	1997-2010	World Bank Database
4A	U5MR	Under-five mortality rate (deaths in the first five years of life, per 1,000 live births)*	Total: 148 IDA: 63	1990-2010	UNICEF CME Database
4A	IMR	Infant mortality rate (deaths in the first year of life, per 1,000 live births)*	Total: 148 IDA: 63	1990-2010	UNICEF CME Database
4A	Measles Immunizatio n	Proportion of 1 year-old children immunized against measles	Total: 120 IDA: 56	1990-2010	World Bank Database
5B	Adolescent birth rate	Number of births per 1,000 women aged 15-19 years	Total: 149 IDA: 60	1997-2010	World Bank Database
6A	HIV Prevalence	Prevalence of HIV, total (% of population aged 15-49)	Total: 114 IDA: 49	1990-2009	World Bank Database
6C	Tuberculosis incidence	Incidence of tuberculosis (per 100,000 people)	Total: 145 IDA: 62	1990-2010	World Bank Database
7A	Total CO_2 emissions	CO_2 emissions in kilo tons	Total: 119 IDA: 54	1990-2008	World Bank Database
7A	Per capita CO_2 emissions	CO_2 emissions per capita in metric tons	Total: 119 IDA: 54	1990-2008	World Bank Database
7B	Proportion of terrestrial and marine areas protected	Proportion of terrestrial and marine areas protected	Total: 109 IDA: 41	1990-2010	World Bank Database
7C	Improved water source (rural)	Improved water source, rural (% of rural population with access)	Total: 111 IDA: 48	1990-2010	World Bank Database
7C	Improved water source	Improved water source, urban (% of urban population with access)	Total: 129 IDA: 52	1990-2010	World Bank Database

	(urban)				
7C	Improved sanitation (rural)	Improved sanitation facilities, rural (% of rural population with access)	Total: 105 IDA: 44	1990-2010	World Bank Database
7C	Improved sanitation (urban)	Improved sanitation facilities, urban (% of urban population with access)	Total: 115 IDA: 45	1990-2010	World Bank Database
8A	Total ODA	Net official development assistance received (measured in current US$)	Total: 115 IDA: 57	1990-2010	World Bank Database
8A	ODA (%GNI)	Net official development assistance received (measured as percentage of gross national income)	Total: 101 IDA: 47	1990-2010	World Bank Database
8D	Debt service	Total debt service as % of exports of goods and services and net income	Total: 67 IDA: 24	1990-2010	World Bank Database

*Estimated by the UN Inter-Agency Group for Child Mortality Estimation (IGME)

CONTROL INDICATORS

The control indicators used in this analysis were identified based on their ease of availability and hence the control datasets are not ideal controls. Better controls would be indicators that (1) were considered for the MDGs but eventually not selected and (2) are not closely related to the selected MDG indicators in terms of activities or outcomes.

For this study, we leveraged the World Bank Database that, as of 4Q 2012 contained 1260 indicators. From the list of 1260 indicators, we identified 377 indicators where annual data from 1990-2010 was available. Of these, 343 were discarded as they were either: (1) MDG indicators; (2) closely related to the MDG indicators (e.g. fertility rate was discarded as the MDG indicator of adolescent birth rate is a subset of fertility rate); (3) related specifically to World Bank financing and not of interest to our study (e.g. currency composition of granted debt); or (4) completely unrelated to development (e.g. land area).

The remaining 24 indicators fall into the broad categories of life expectancy, agricultural development, financial investment and military expenses. We left out the category of life expectancy from the set of controls since life expectancy is strongly determined by infant mortality rate, U5 mortality rate, HIV rate and other MDG indicators. We selected 7 indicators from the remaining categories. Appendix B contains a description of indicators within this group that were not selected for our study.

Aside from indicators on agricultural development, investment and military expenses, we would have liked to have important health-specific development indicators that were not included in the MDGs, for example cardiovascular mortality rates, but data was generally not available. These indicators of non-communicable diseases are receiving increasing attention by developing countries and may likely play a prominent role in the post-2015 MDG discussion. Additionally, other control indicators that were desirable, but not available, included the incidence of child marriage or child labor measures.

We did manage to identify WHO data on lung cancer mortality produced by the International Agency for Research on Cancer for a small sample of 23 countries from 1990-2010. Lung cancer was specifically chosen as it is the leading cancer in many countries. Although the sample size was smaller than our selection criterion, we decided to include it as a health-specific control indicator for comparison with the health-related MDG indicators.

Of the control indicators selected, crop production and food production can easily be argued to be important for development but not included in the MDGs. Armed forces and military expenditures can be argued to be related to whether the planet is becoming more or less violent/militarized where one can easily conceive that a more peaceful planet is an important goal.

Table 2 contains a description of our 9 control indicators (7 from the World Bank Database and 2 from the WHO data on lung cancer mortality).

Table 2: Control Indicators

Indicator Code	Definition	Number of Countries	Data Availability	Data Source
Crop production	Crop production index (2004-2006 = 100)	Total: 119 IDA: 56	1990-2010	World Bank Database
Food production	Food production index (2004-2006 = 100)	Total: 119 IDA: 56	1990-2010	World Bank Database
Foreign Direct Investment (FDI)	Foreign direct investment, net inflows (% of GDP)	Total: 101 IDA: 43	1990-2010	World Bank Database
Household consumption	Household final consumption expenditure (current US$)	Total: 95 IDA: 30	1990-2010	World Bank Database
Armed forces	Armed forces personnel (% of total labor force)	Total: 65 IDA: 22	1990-2010	World Bank Database
Military expenditure	Military expenditure (% of GDP)	Total: 56 IDA: 14	1990-2010	World Bank Database
Net Income from Abroad (Current USD)	Net income includes net labor income (compensation of employees), net property and entrepreneurial income (e.g. interest, rent, patents, copyrights).	Total: 114 IDA: 47	1990-2010	World Bank Database
Lung cancer mortality (male)	Age-standardized rates of lung cancer (per 100,000 males)	Total: 23 IDA: 2	1990-2010	WHO (IARC Database)
Lung cancer mortality (female)	Age-standardized rates of lung cancer (per 100,000 females)	Total: 23 IDA: 2	1990-2010	WHO (IARC Database)

Methodology and Modeling

Objectives

We aim to explore three questions: (1) was there a statistically significant interruption in the time series; (2) if there was an interruption in the time series, was there an acceleration or deceleration of progress towards the MDGs; and (3) did the interruption occur before or after the MDG Declaration in September 2000? These questions allow us to identify if the initiation of the MDGs was associated with any acceleration in progress on the MDG development indicators.

We then go a step further to try to draw a causal link between the initiation of the MDGs and any acceleration in progress on the MDG indicators. If the acceleration in progress on the MDG indicators was not specifically associated with the activities and programs surrounding the initiation of the MDGs, but was reflecting an overall improvement in development due to other factors, we would expect our control indicators to show the same pattern of accelerated progress. Hence, we ran the same models on our selected control indicators to identify if the same pattern of acceleration (or deceleration) occurred.

The Model

We took the systematic approach of modeling all data as having a trend line and a single interrupted year where that interruption could be an interrupted slope and interrupted intercept. Proposed "interrupted years" encompassed all years in the dataset excluding the end points (i.e. a dataset with values from 1990-2010 was tested for 17 proposed interruptions in 1992, 1993 and so on until 2008).

As shown below, we used a linear mixed model with an interrupted intercept and an interrupted slope. We also explored other models with only the interrupted intercept or only the interrupted slope, but found the model below to be the optimal model as it was general enough to be systematically applied to all datasets used.

$$\log(y) = \beta_0 + \beta_1 t + \beta_2 I + \beta_3 Z + \epsilon_1 + \epsilon_2 t + \epsilon_3 I + \epsilon_4 Z + \mu$$

where:

- y is the dependent variable, which is either an MDG or control indicator. We used logged values to minimize the effect of heavy influence countries and bring the raw data closer to a normal distribution. Since we are using logged values, a unit increase in any of the independent variables, say a 1 unit increase in t, leads to a $100\beta_1$% increase in y.
- β_0 is a constant term representing the intercept.
- $\beta_0, \beta_1, \beta_2, \beta_3$ are fixed effect coefficients.
- t is the time variable taking on the values [-10,10], as the time period [1990,2010] was standardized to [-10,10]. The coefficient β_1 is the growth rate, representing a $100\beta_1\%$ change in y every year.
- I is a binary variable where

$$I = \begin{cases} 0 \; if \; year < interrupted \; year \\ 1 \; if \; year \geq interrupted \; year \end{cases}$$

  A statistically significant β_2 coefficient represents a step change in the time series (i.e. a change in the intercept or interrupted intercept) starting at the interrupted year.
- Z is a variable where

$$Z = \begin{cases} 0 & if \; year < interrupted \; year \\ (year - interrupted \; year) & if \; year \geq interrupted \; year \end{cases}$$

A statistically significant β_3 coefficient represents a slope change in the time series (i.e. a change in the slope or interrupted slope) starting at the interrupted year. The correlation matrix was assumed to be unstructured.

Linear mixed models were constructed for each indicator for each possible interrupted year. The optimal interrupted year corresponded to the interrupted year that gave the maximum goodness of fit for the model (i.e. the minimum Bayes Information Criterion, BIC). The model for the optimal year was used to identify if there was a statistically significant interruption in the trend. Later, it was also used to identify heavy influence countries for robustness checks.

We are primarily interested in looking for a statistically significant β_3 coefficient as it represents a slope change in the time series starting at the interrupted year. This represents the most plausible way in which the MDGs could have impacted the indicators. The direction of β_2 and β_3 was examined to determine if it suggested an acceleration or a deceleration in the trend. For a few indicators, there appeared to have been a significant interrupted intercept rather than an interrupted slope – indicating that there was a step shift in the optimal year rather than a change in the trend.

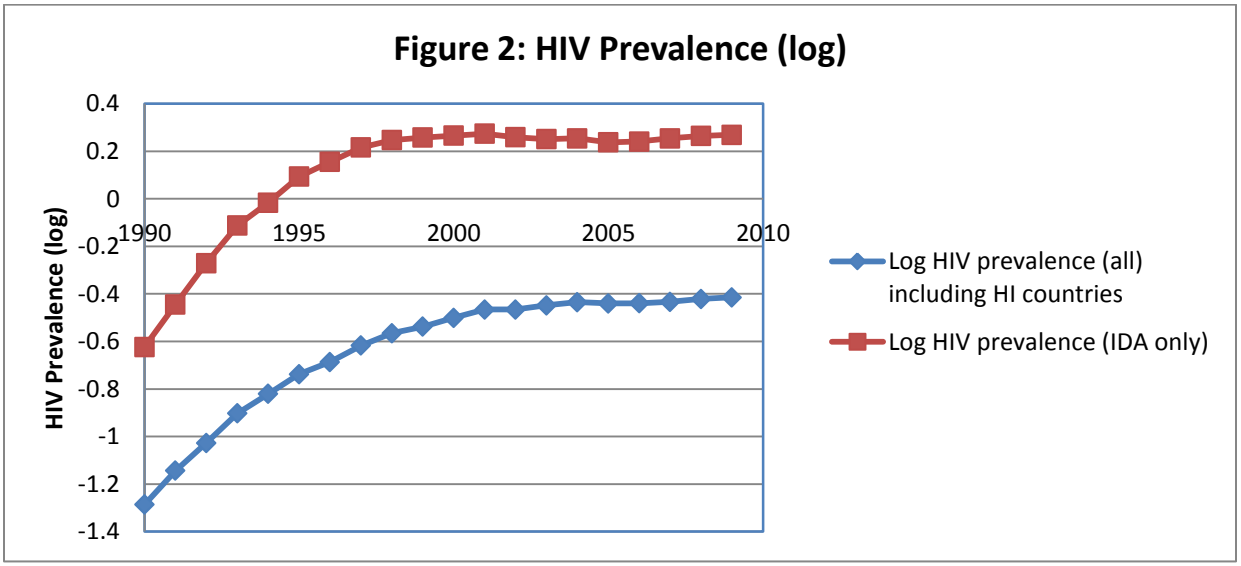
- $\epsilon_1, \epsilon_2, \epsilon_3, \epsilon_4$ are country-specific random effect coefficients. We assume that coefficients for the intercept, trend, interrupted year and interrupted slope may vary by country. Further, we place no constraints on the covariance matrix for these random effects, such that:

$$\psi = V\begin{bmatrix}\epsilon_1\\ \epsilon_2\\ \epsilon_3\\ \epsilon_4\end{bmatrix} = \left[\begin{pmatrix}\psi_1^2 & \cdots & \psi_{14}\\ \vdots & \ddots & \vdots\\ \psi_{41} & \cdots & \psi_4^2\end{pmatrix}\right]$$

- Lastly, μ is an individual-level error term where $\mu \sim iid\ N(0, \sigma^2)$.

Illustration of How the Model Works

We demonstrate the specific steps in our analysis using HIV prevalence as an example. We then display other examples where an interrupted time series was identified by the model, and where there was no interruption in the time series. A full description of the analysis appears for each MDG in Appendix C.



The steps in our analysis are:

(1) Transform the y-variable (in this case HIV prevalence) to log HIV prevalence and examine the distribution.

(2) Develop time series projections using 1990-1999 as baseline years and then explore visually if there appears to have been an interruption in the time series, and, if so, whether the visual inspection suggests when the interruption occurred. The HIV curve was compared with time series projections of the outcome variable where the time period 1990 to 1999 was used as an input and the time series projection was produced for the period 2000 to 2010. In addition to the time series, a linear regression model was developed using time as the x-variable and the indicator variable as the y for the time period 1990 to 1999 and then extrapolated to cover the period 2000 to 2010. The regression model was produced as a back-up in case other time series forecasting methods did not converge though it is known that the input time series data violates basic assumptions of linear regression. Visual inspection was then performed on three curves, the actual time series of the indicator, the time series projection and the regression projection. For the example above, the HIV prevalence data indicates that there was an interrupted slope starting in the late 1990's for both the IDA-only countries and the IDA, IBRD and Blend countries. That is to say, the rate of increase in the log HIV prevalence changed starting in the late 1990's based on visual inspection and comparison with time series projections (see Figure 11)

(3) Using the full dataset (1990-2010), construct a linear mixed model for the target variable for each potential interrupted year ranging from 1992 to 2008.

(4) Record the Bayes Information Criterion (BIC), interrupted intercept coefficient, interrupted slope coefficient, and corresponding p-values for each potential interrupted year from 1992 to 2008.

(5) Select the interrupted year corresponding to the minimum BIC. Since each of these interrupted year models has the same number of degrees of freedom, the model with the minimum BIC is representing the model that explains the greatest amount of variability in the dataset.
The proposed interrupted year that produced the lowest value for the BIC was identified as the year in which an interruption in the time series trend occurred.

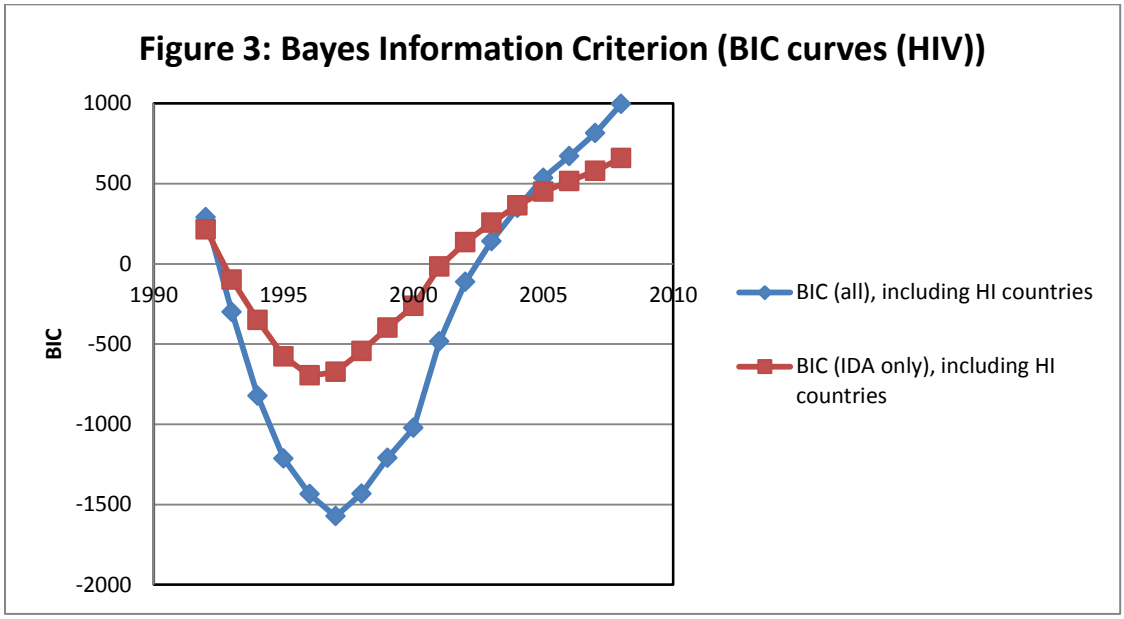
The BIC is calculated as follows:

$$-2 * \ln p(x|k) \approx BIC = -2 * lnL + kln(n)$$

where:

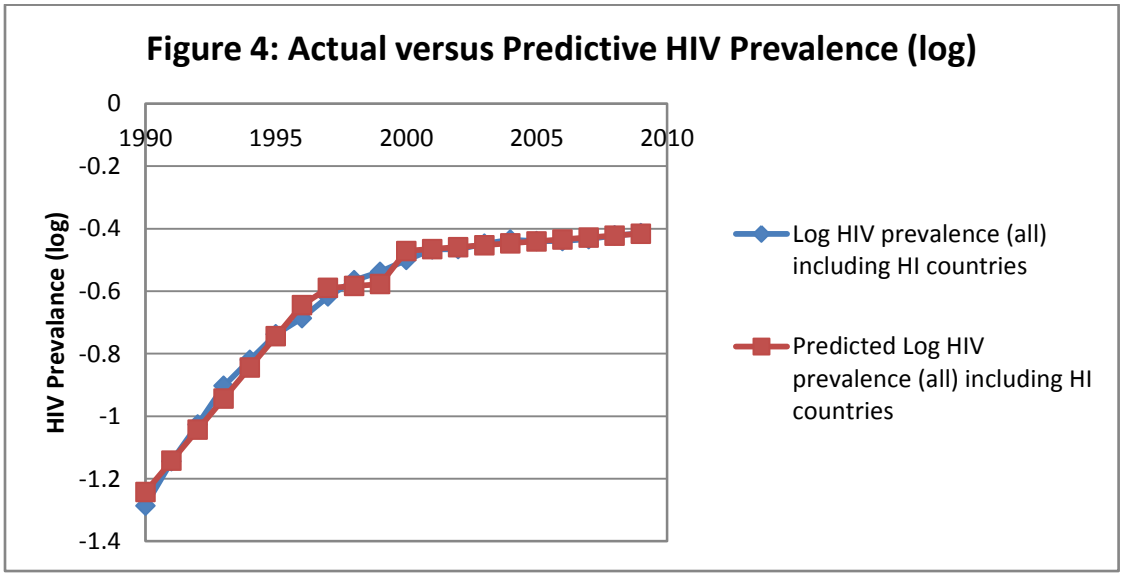
- x is the observed data
- n is the number of data points in x, (or the sample size)
- k is the number of free parameters to be estimated.
- p(x|k) is the likelihood of the parameters given the dataset
- L is the maximized value of the likelihood function for the estimated model.

Below is the plot of BIC as a function of year for the log HIV prevalence model. One can easily see that the minimum BIC occurred in 1997 for the IDA, IBRD and Blend dataset displayed below. This year corresponds well to the year identified via visual inspection (Figure 2) and in comparison to the time series projections (Figure 11).



(6) Record the coefficients on the interrupted slope and intercept for the model with the optimal interrupted year – the year that gives the best goodness of fit (i.e. minimum BIC). In this example, the optimal model had an interrupted year in 1997, and a statistically significant interrupted slope ($p<0.0001$) that was negative. This negative interrupted slope indicates that the annual increase in HIV prevalence started slowing down around 1997.

(7) Predict log HIV prevalence using the model with the selected year (in this case 1997) and compare it to the actuals. We can see below that the predicted curve is very close to the observed curve.



(8) Identify the heavy influence countries by selecting countries that had a Restricted Likelihood Distance > 5 or a Cook's distance >0.3. In the case of HIV prevalence, only one country was identified as a heavy influence country, the Russian Federation.

(9) Remove the heavy influence countries and repeat steps (2) through (7) noting any major changes in the model interpretations based on including or dropping heavy influence countries. The heavy influence countries are important as they point to countries whose patterns were different than the global trends. The heavy influence countries may represent positive or negative patterns and, as such, can point to potential future research.

(10) A fixed effect polynomial time function was added to the interrupted time series model to see if the results were robust to the more complicated model structure. It is important to note that the interpretation of the interrupted slope/intercept in a fixed effect polynomial time function is different from that of a linear time function and so conclusions drawn on this model should be taken with care. From a computational point of view, when a fixed effect polynomial time function is added to the model, this means that the interrupted slope/intercept must be incremental to the polynomial curvature. Specifically, a time series that is well fit by a second order time polynomial will likely be identified as having (a) a statistically significant interrupted slope/intercept when there is only a first order fixed effect time polynomial but (b) not having a statistically significant interrupted slope/intercept when a second order fixed effect time polynomial is added since the second order polynomial captures the shift in the time series that was represented by the interrupted slope/intercept in the first order fixed effect model.

This same methodology of analysis was replicated for all indicators.

Aside from HIV prevalence, a clear interruption was seen for tuberculosis incidence (interruption in 1999/2000); total ODA (interruption in 1999) and GDP per person employed (interruption in 1996) as shown below.

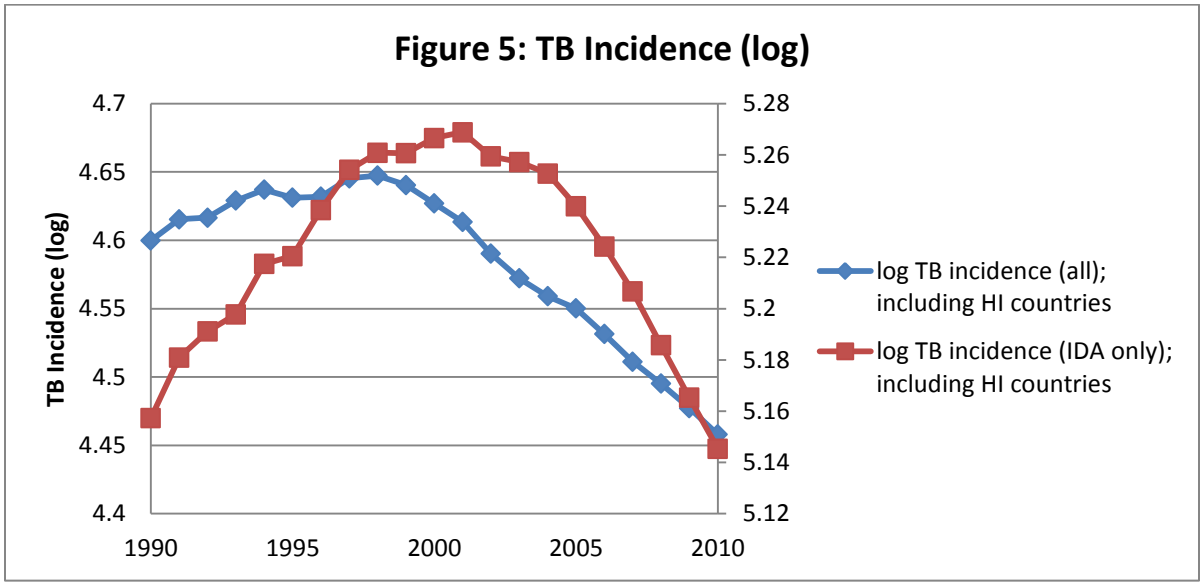


Figure 5: TB Incidence (log)
TB Incidence (log)
4.7
4.65
4.6
4.55
4.5
4.45
4.4
5.28
5.26
5.24
5.22
5.2
5.18
5.16
5.14
5.12
1990
1995
2000
2005
2010
log TB incidence (all); including HI countries
log TB incidence (IDA only); including HI countries

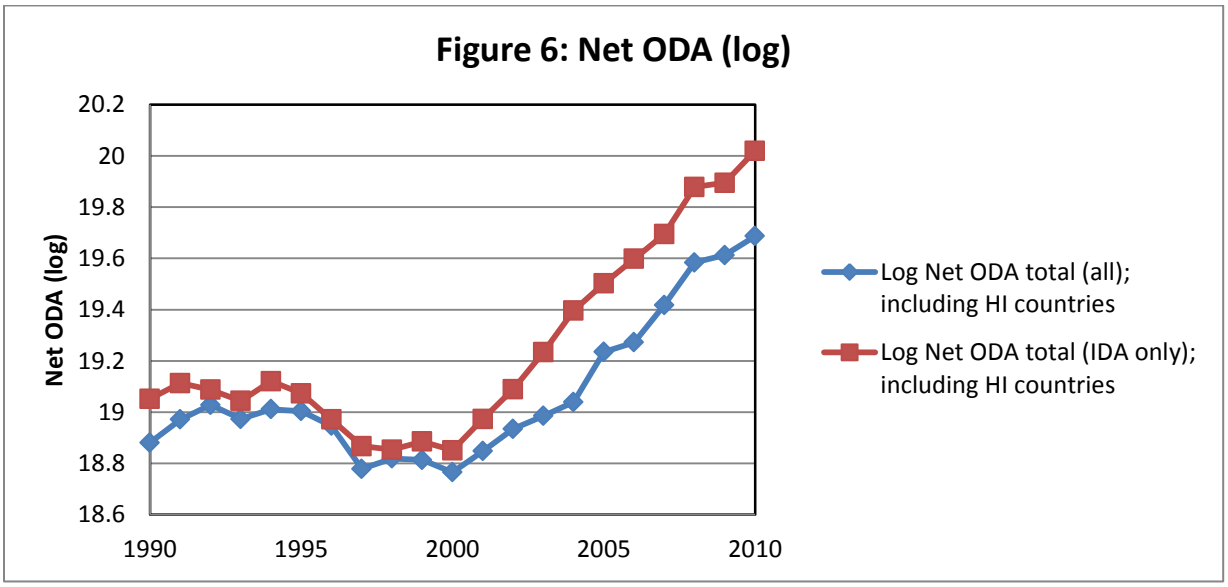
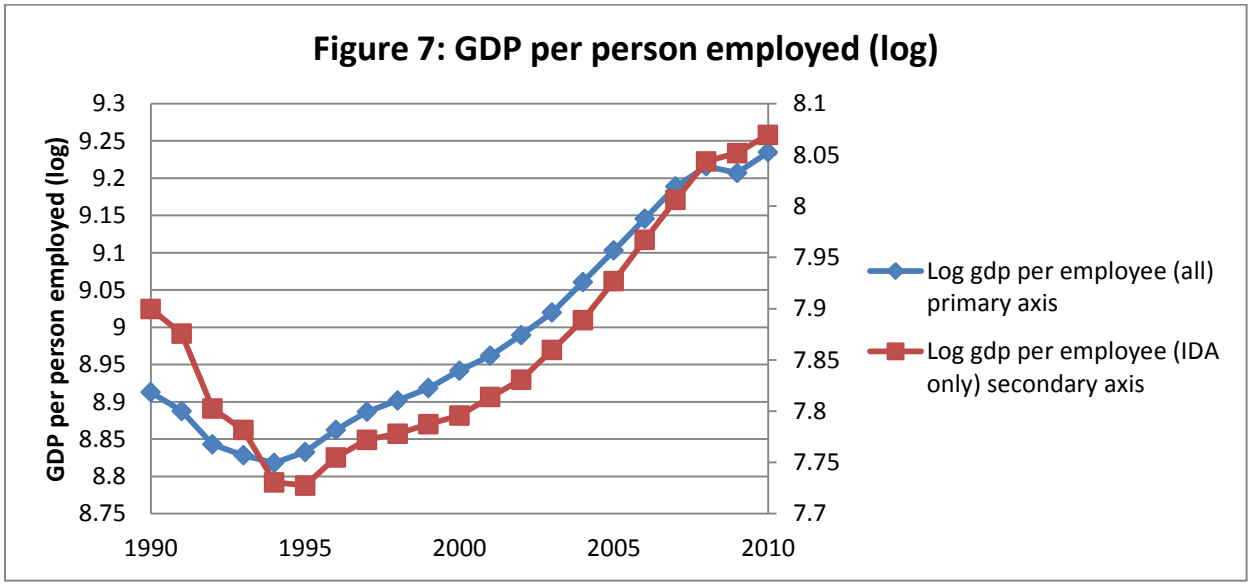
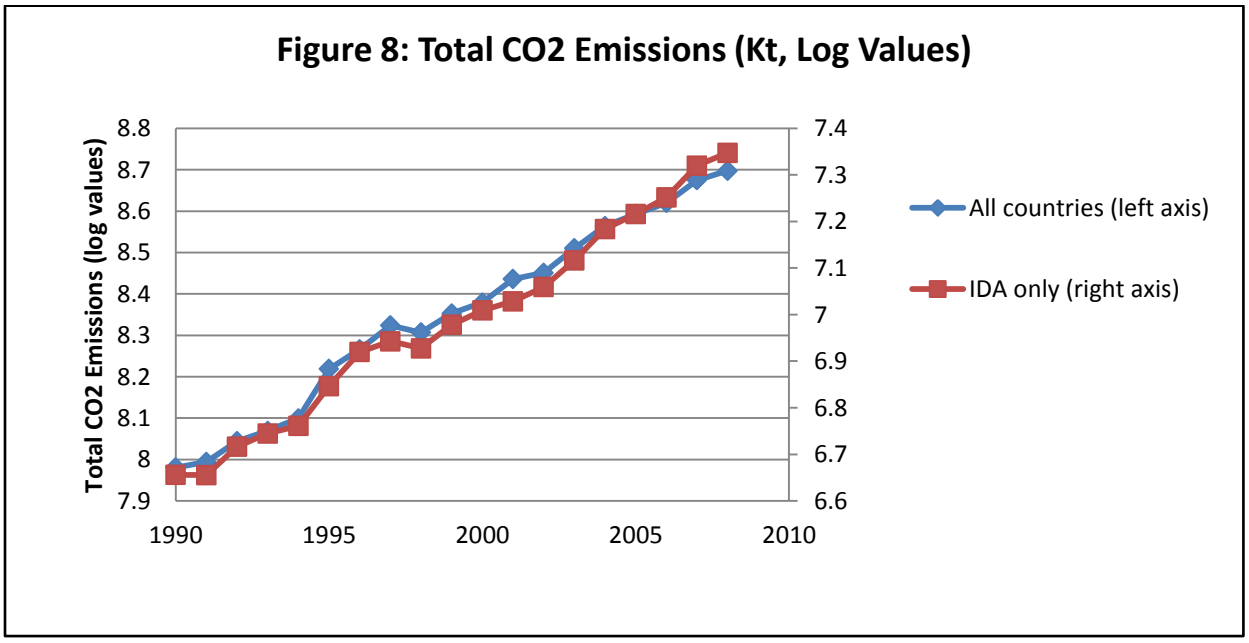
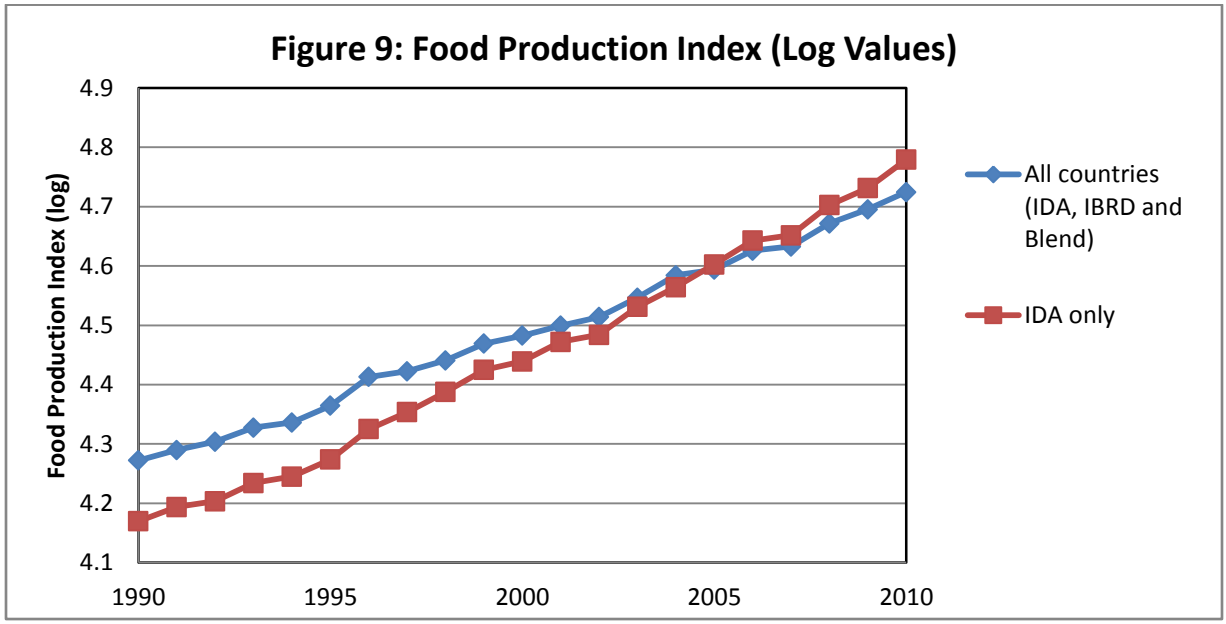


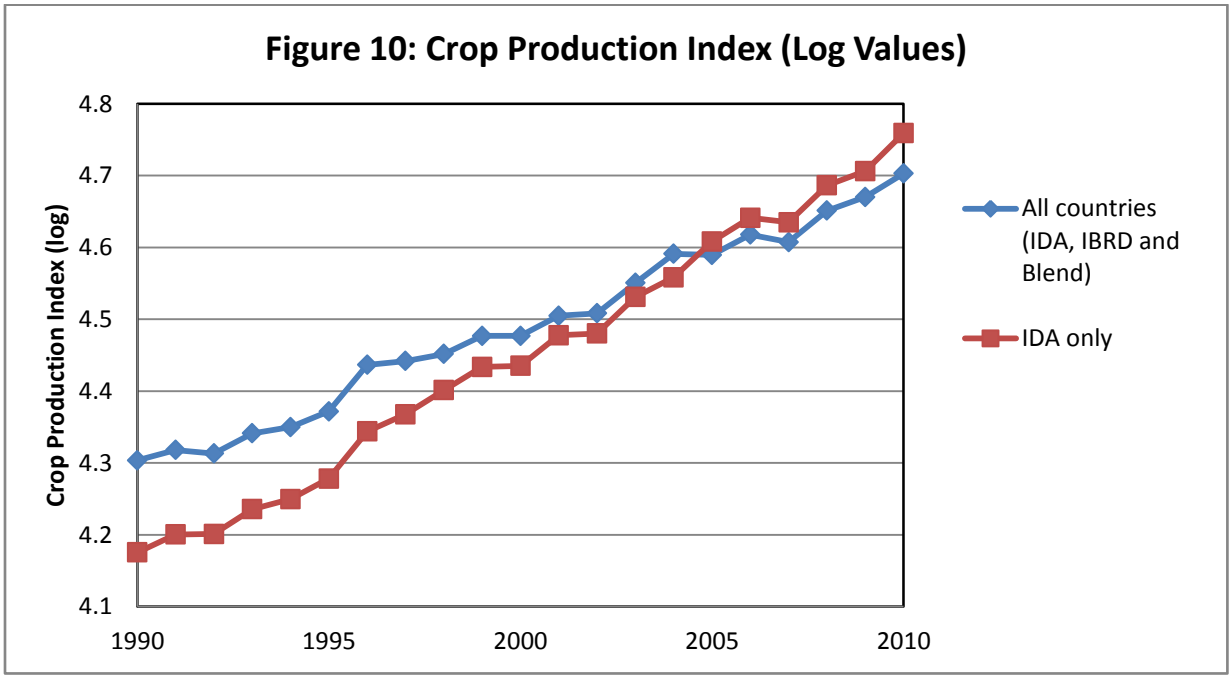
Figure 6: Net ODA (log)
Net ODA (log)
20.2
20
19.8
19.6
19.4
19.2
19
18.8
18.6
1990
1995
2000
2005
2010
Log Net ODA total (all); including HI countries
Log Net ODA total (IDA only); including HI countries



Our model did not identify an interruption in the total CO_2 emissions nor in most of the control indicators such as food production. Visually, these graphs present as near-straight lines with no changes in slope as shown in Figures 5-7.







Robustness Checks

We ran 5 different robustness checks for our model to ensure the reliability of our results:

(a) Removing heavy influence countries

Heavy influence countries in each dataset were identified using Cook's distance (>0.3) and Restricted Likelihood Distance (>5). The heavy influence countries were dropped and the regressions were re-

estimated. It was found that, in most cases, removing heavy influence countries did not generally alter the conclusions of the analysis.

(b) Examining quality of fit by analyzing residuals

The quality of fit of the model to the data was assessed by examining the pattern and magnitude of the residuals. The Kolmogorov-Smirnov test revealed that the residuals did not fit a normal distribution. However, the magnitude of the residuals was comparatively small. We measured the magnitude of residuals using the absolute percent deviation from the actual, or $\left|\frac{Predicted\ Log\ Value - Actual\ Log\ Value\ of\ Indicator}{Actual\ Log\ Value}\right|$. This absolute percent deviation was less than 1% for most of the datasets. For 5 datasets, the residuals were slightly larger at about 2-7%, with residuals for a few years going above that (but still below 25% of the magnitude of the actual log values). These data sets with larger absolute percent deviations tended to have denominators close to zero thus inflating the measured absolute percent deviation. In general, the quality of fit was satisfactory for most indicators.

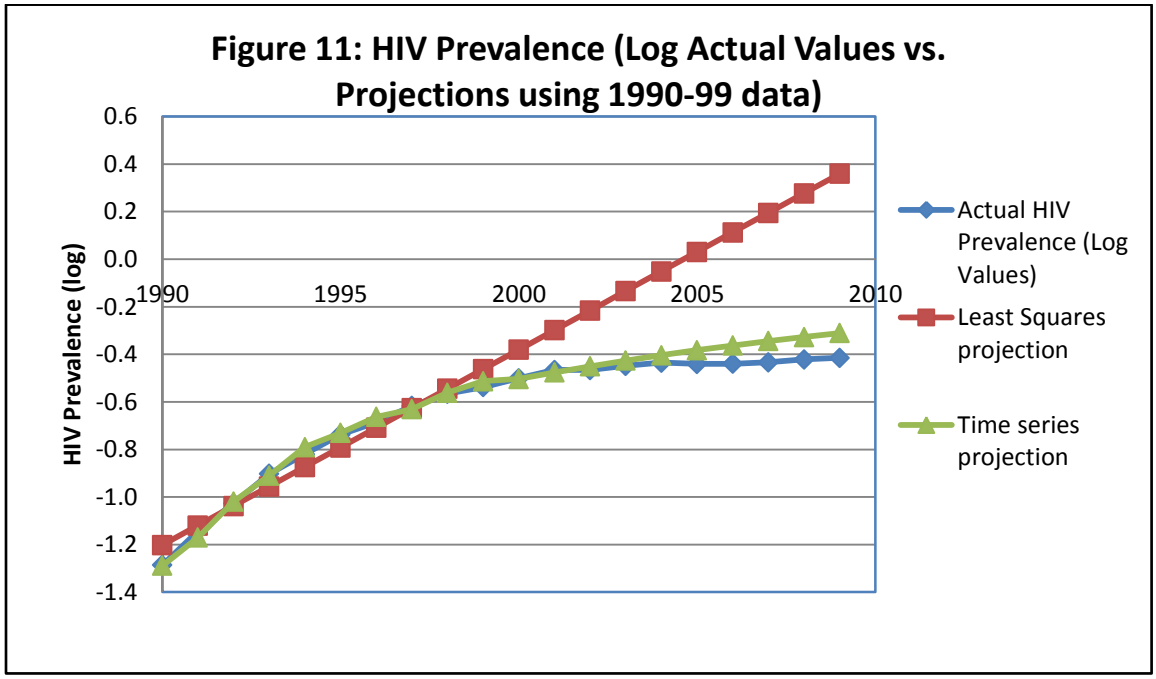
(c) Visual inspection

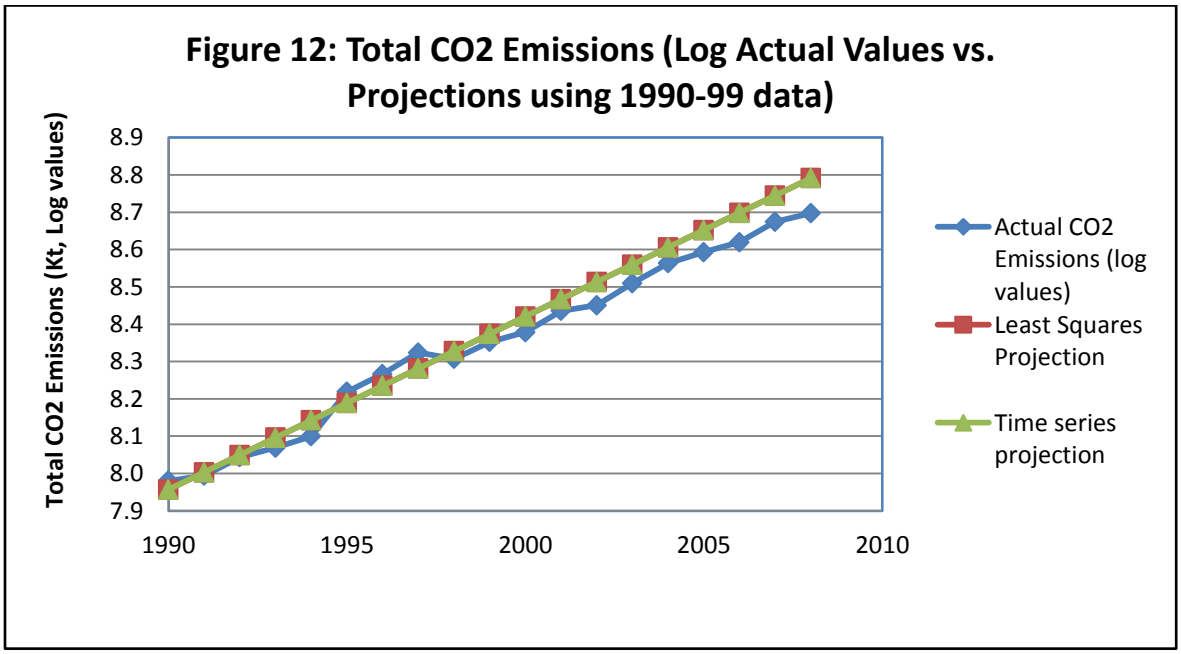
We also used visual inspection to examine whether the year where an interruption in the time series occurred (as identified by the statistical analysis) agreed with visual inspection of the graphs of the raw data. The results from the interrupted time series analysis generally concurred with the results from visual inspections.

(d) Least squares and time series projections

In order to supplement the visual inspection, we made use of data from all countries from 1990-1999 to project outcomes post-2000. Both least squares and time series projections were used. The actual data was compared with the projections to see if an interruption in the time series occurred after 2000.

In Figures 11 and 12, we show two examples of projections that we made for HIV prevalence and total CO_2 emissions.





The projections indicated a significant interruption in the time series around 1999 for HIV prevalence and no interruption in the time series for total CO_2 emissions. These visual inspection observations are in line with our modeling results (statistically significant interruption in 1997 for HIV prevalence and no statistically significant interruption for CO_2 emissions respectively). In general, the statistically derived results agreed with visual inspection.

(e) Including fixed effect polynomial variable

As a model with two trend lines may be criticized for not being able to fit the data well, we added a fixed effect polynomial term $t * t$ (a squared time variable) to our regressions to see if it impacted our results. It should be noted that using a polynomial term in an interrupted time series shifts the interpretation of the interrupted slope and intercept coefficients – we are no longer testing if there was a shift from a linear trend but rather testing if there was a shift from a polynomial trend. As a result of this shift in interpretation of the interrupted slope and intercept coefficients, this analysis is not a focus of the study but the results are nonetheless reported.

Our new model is as follows:

$$\log(y) = \beta_0 + \beta_1 t + \beta_2 I + \beta_3 Z + \beta_4 t * t + \epsilon_1 + \epsilon_2 t + \epsilon_3 I + \epsilon_4 Z + \mu$$

However, the addition of a polynomial term did not generally change our results. As was stated previously, the interpretation of the interrupted slope/intercept in a fixed effect polynomial time function is different from that of a linear time function and so conclusions draw on this model should be taken with care.

Results and Analysis

Before presenting a more detailed review of the results, we will first present summary tables and graphs representing the overall trends. Detailed analyses of each MDG indicator are provided in Appendix C.

As seen in Table 3, about half of the MDG indicators and the vast majority of the non-MDG indicators had no acceleration or deceleration during the observation period 1990 to 2010. The MDG indicators that had an acceleration nearly universally experienced that acceleration in 2000 or earlier, meaning that the acceleration could not have causally been linked to the MDG Declaration. The primary exception to this observation was the MDG indicator related to total debt service where the shift occurred around 2001/2002.

There were some MDG indicators that experienced decelerations, rather than accelerations. Some of these decelerating MDGs are indicators that have a maximum of 100%. While this could plausibly be due to a ceiling effect, the actual values were generally noticeably below 100% so the ceiling effect concerns are not likely to be a primary explanation. Examples of indicators that had some form of a deceleration during the time period include proportion of terrestrial and marine areas protected, percentage of urban population with improved water sources, and percentage of urban/rural population with access to improved sanitation facilities.

Table 3: Summary results of Interrupted Time Series Analysis

	MDG Indicators (19 indicators)			
	IDA, IBRD and Blend Countries		IDA Only	
	All countries	Dropping HI countries	All countries	Dropping HI countries
No Acceleration or Deceleration	10	6	12	10
Acceleration 2000 or before	6	6	6	4
Acceleration 2001 or after	1	2	1	3
Deceleration 2000 or before	1	2	0	2
Deceleration 2001 or after	1	3	0	0

	Non-MDG Indicators (9 indicators)			
	IDA, IBRD and Blend Countries		IDA Only	
	All countries	Dropping HI countries	All countries	Dropping HI countries
No Acceleration or Deceleration	6	6	5	5
Acceleration 2000 or before	0	0	0	0
Acceleration 2001 or after	1	1	1	1
Deceleration 2000 or before	1	1	1	1
Deceleration 2001 or after	0	0	0	0
Modeling limitations*	1	1	2	2

*Modeling limitations means either the model did not converge or that there were not enough countries to run the model.

For the more detailed summary presentation, we present the following items in our results table for two categories – all countries (IDA, IBRD and Blend); and IDA countries only:

(a) **The interrupted year** – as identified by the optimal proposed interrupted year, that is, the proposed interrupted year that corresponds to the lowest BIC for all regressions on a dataset.

(b) **Statistical significance (of $\boldsymbol{\beta_2}$ and $\boldsymbol{\beta_3}$)** the coefficients on the interrupted slope and interrupted intercept variables. We are primarily interested in identifying if the model had a statistically significant β_3 which would indicate that there was a statistically significant interrupted slope in the time series in the identified year but we also identified data sets with a statistically significant interrupted intercept (β_2). We tested 17 time points from 1992 to 2008 for an interruption in the time series for datasets with data from 1990 to 2010. A conservative test for significance overall at the 5% level uses a Bonferroni correction such that the threshold for significance for each potential interrupted year was $p = \frac{0.05}{17} = 0.00294$. We use this p-value for our tests for significance.

(c) **Acceleration/Deceleration.** For indicators where the interrupted slope or intercept was statistically significant at the Bonferroni adjusted level, we identified if the interruption represents an acceleration or deceleration towards the MDG goal.

Our results will be presented in 4 tables. Table 4 presents the results for the MDG indicators with all countries in the dataset included. Table 5 present the results for the MDG indicators with heavy influence countries dropped. Similarly, Tables 6 and 7 present the results for control indicators for the full dataset and excluding heavy influence countries respectively.

In Appendix C, we provide a detailed review of each step in the analysis of each MDG indicator.

MDG INDICATORS

Table 4: Results for MDG Indicators (Including Heavy Influence Countries)

MDG Indicators	IDA, IBRD, Blend Countries			IDA Countries only		
	Identified Year with Lowest BIC	Statistically Significant Change	Acceleration/ Deceleration	Identified Year with Lowest BIC	Statistically Significant Change	Acceleration/ Deceleration
1B Employment-to-population ratio	2001	No	None	2002	No	None
1B GDP per person employed	1996	Yes	Acceleration	1996	Yes	Acceleration
3A Proportion of women in parliament	2008	No	None	2006	No	None
4A Infant mortality rate	1999	Yes	Acceleration	1998	Yes	Acceleration
4A Proportion of 1 year-old children immunised against measles	2000	No	None	2000	No	None
4A Under-five mortality rate	2000	Yes	Acceleration	1997	Yes	Acceleration
5B Adolescent birth rate	2004	Yes	Deceleration	2004	No	None
6A HIV prevalence among population aged 15-24	1997	Yes	Acceleration	1996	Yes	Acceleration
6C Incidence of tuberculosis (per 100,000 people)	2000	Yes	Acceleration	1999	Yes	Acceleration
7A CO2 emissions (metric tons per capita)	1995	No	None	1998	No	None
7A CO2 total (kt)	1995	No	None	1998	No	None
7B Proportion of terrestrial and marine areas protected	2000	Yes	Deceleration	1999	No	None
7C Improved water source (% rural population)	1996	No	None	1996	No	None
7C Improved water source (% urban population)	1996	No	None	1996	No	None
7C Improved sanitation (% rural population)	1995	No	None	1995	No	None
7C Improved sanitation (% urban population)	1998	No	None	1995	No	None
8A Net ODA (% of GNI)	2003	No	None	2003	No	None
8A Net ODA received (current US$)	1999	Yes	Acceleration	1999	Yes	Acceleration
8D Total Debt Service	2001	Yes	Acceleration	2002	Yes	Acceleration

ANALYSIS OF RESULTS FOR MDG INDICATORS (INCLUDING HEAVY INFLUENCE COUNTRIES)

We found a statistically significant acceleration in the time series for 7 out of 19 MDG indicators as highlighted in Table 4. Of these 7 indicators, only 1 had its changepoint year in 2001 or later. This indicates that an acceleration in the progress of development in these indicators occurred before the activities associated with the initiation of the MDGs. Of the 6 health-related MGD's in Table 4, 4 had an acceleration in 2000 or earlier and none had an acceleration in 2001 or later.

Non-health-related indicators that showed a statistically significant interruption in the time series, such as GDP per person employed, may have been more subject to economic conditions than the initiation of MDGs. GDP per person employed had a positive and statistically significant interrupted intercept in the identified year for both sets of countries (all countries and IDA only) in 1996.

Total debt service was the only indicator that consistently showed acceleration in progress after 2000, possibly indicating that activities related to debt financing initiated by the MDGs were successful in accelerating progress on this indicator. In particular, the MDGs mobilized support for the Monterrey Consensus in 2002, which brought new debt relief commitments by the US and EU and enlisted support from international organizations such as the World Bank and IMF for debt reduction. This event coincides with the identified year when the interrupted trend occurred for IDA only countries.

We find that in general, there does not seem to be a divergence between the group of all developing countries (IBRD, IDA only and Blend) and the subgroup of IDA only countries. In situations in which there was a significant time series interruption, the interruption generally occurred in the same period for both groups, and the statistical significance of the interrupted intercept/slope coefficients was generally consistent across the two groups. In essence, IDA countries show a similar pattern of development to the larger group of developing countries.

Table 5: Results for MDG Indicators (Excluding Heavy Influence Countries)

MDG Indicators	IDA, IBRD, Blend Countries			IDA Countries only		
	Identified Year with Lowest BIC	Statistically Significant Change	Acceleration/ Deceleration	Identified Year with Lowest BIC	Statistically Significant Change	Acceleration/ Deceleration
1B Employment-to-population ratio	2001	Yes	Acceleration	2002	No	None
1B GDP per person employed	1996	Yes	Acceleration	1996	Yes	Acceleration
3A Proportion of women in parliament	2002	No	None	2003	No	None
4A Infant mortality rate	1999	Yes	Acceleration	1997	Yes	Acceleration
4A Proportion of 1 year-old children immunised against measles	1998	No	None	2000	No	None
4A Under-five mortality rate	1999	Yes	Acceleration	1997	Yes	Acceleration
5B Adolescent birth rate	2004	Yes	Deceleration	2004	No	None
6A HIV prevalence among population aged 15-24	1997	Yes	Acceleration	1996	Yes	Acceleration
6C Incidence of tuberculosis (per 100,000 people)	2000	Yes	Acceleration	2001	Yes	Acceleration
7A CO2 emissions (metric tons per capita)	1998	No	None	1998	No	None
7A CO2 total (kt)	1998	No	None	1998	No	None
7B Proportion of terrestrial and marine areas protected	1996	No	None	1996	No	None
7C Improved water source (% rural population)	1997	Yes	Deceleration	1997	Yes	Deceleration
7C Improved water source (% urban population)	2001	Yes	Deceleration	1997	No	None
7C Improved sanitation (% rural population)	1999	Yes	Deceleration	1997	No	None
7C Improved sanitation (% urban population)	2006	Yes	Deceleration	1995	No	None
8A Net ODA (% of GNI)	2003	No	None	1997	Yes	Deceleration*
8A Net ODA received (current US$)	2000	Yes	Acceleration	2002	Yes	Acceleration
8D Total Debt Service	2002	Yes	Acceleration	2007	Yes	Acceleration

*Note: It was assumed that an increase in net ODA meant acceleration and a decrease in net ODA meant deceleration.

Analysis of Results for MDG Indicators (Excluding Heavy influence countries)

We ran the same regressions omitting heavy influence countries (identified by Cook's distance >0.3, Restricted Likelihood Distance>5) where the heavy influence countries varied depending on the indicator and set of countries (IDA, IBRD and Blend versus IDA only) used. The general conclusion, that there was a lack of evidence for accelerations following the 2000 MDG Declaration, was robust to the inclusion or exclusion of heavy influence countries. In most situations in which there was a statistically significant result in Table 4 (including heavy influence countries), dropping heavy influence countries (Table 5) mainly shifted the identified interrupted year by one or two years for most of the datasets.

The major changes associated with dropping heavy influence countries are for the indicators regarding improved water source and sanitation. Dropping the heavy influence countries causes the interrupted time series coefficients on improved water source and improved sanitation to become statistically significant (decelerating). This indicates that when heavy influence countries are excluded, the models generally display a slowdown in progress on improving water sources and sanitation for their urban populations.

The other major change is for the indicator total debt service. Dropping heavy influence countries causes the identified interrupted year to change from 2002 to 2007 for IDA only countries.

Control Indicators

Table 6: Results for Control Indicators (Including Heavy Influence Countries)

Control Indicators	IDA, IBRD, Blend Countries			IDA Countries only		
	Identified Year with Lowest BIC	Statistically Significant Change	Acceleration/ Deceleration	Identified Year with Lowest BIC	Statistically Significant Change	Acceleration/ Deceleration
Crop production index (2004-2006 = 100)	2003	No	None	2004	No	None
Food production index (2004-2006 = 100)	2004	No	None	2004	No	None
Foreign direct investment, net inflows (% of GDP)	1997	No	None	1997	No	None
Household final consumption expenditure (current US$)	2002	Yes	Acceleration	2001	Yes	Acceleration
Armed forces personnel* (% of total labor force)	1995	Yes	Deceleration	1995	Yes	Deceleration
Military expenditure (% of GDP)	1998	No	None	1998	No	None
Net Income from Abroad (Current US$)	Model did not converge			2006	No	None
Male age-standardized rates of lung cancer (per 100,000 males)	1997	No	None	Insufficient data		
Female age-standardized rates of lung cancer (per 100,000 females)	1994	No	None	Insufficient data		

* The coefficient on the interrupted intercept β_2 was statistically significant for armed forces personnel (% total labour force) for all countries and IDA countries.

Analysis of Results for Control Indicators (All Countries Included)

For our control indicators shown in Table 6, we find that there was no statistically significant acceleration in the time series for all indicators except household final consumption – which showed acceleration in trend post-2000. This may have been due to capital inflows from more developed countries fueling domestic consumption in developing countries in the early 2000s, when the developed countries were experiencing a recession and capital outflows.

The health-related control indicators for lung cancer showed no statistically significant change in trend, although we are hesitant to rely on this result as the sample size is very small (23 countries, below the threshold that was set for the MDG indicators).

We also found that the results of the time series analysis were consistent between all developing countries (IDA, IBRD and Blend countries) and the subgroup of IDA only countries, indicating that the pattern of development was similar for both sets of countries. As shown in Table 6, the identified years and statistical significance of the results were almost identical across both sets of countries.

As was discussed previously, the control indicators were identified based on data availability and other indicators that may be more appropriate could likely be found through a more intense data search. Specifically, if indicators can be identified that were part of the discussion for the MDG indicator identification but were not selected (and are not directly linked to those that were selected) then those indicators may be superior to the ones we used.

Analysis of Results for Control Indicators (Excluding Heavy Influence Countries)

As seen in Table 7, excluding heavy influence countries had almost no impact in the results.

Table 7: Results for Control Indicators (Excluding Heavy Influence Countries)

Control Indicators	**IDA, IBRD, Blend Countries**			**IDA Countries only**		
	Identified Year with Lowest BIC	**Statistically Significant Change**	**Acceleration/ Deceleration**	**Identified Year with Lowest BIC**	**Statistically Significant Change**	**Acceleration/ Deceleration**
Crop production index (2004-2006 = 100)	2003	No	None	2004	No	None
Food production index (2004-2006 = 100)	2004	No	None	2004	No	None
Foreign direct investment, net inflows (% of GDP)	2007	No	None	2004	No	None
Household final consumption expenditure (current US$)	2002	Yes	Acceleration	2001	Yes	Acceleration
Armed forces personnel (% of total labor force)	1995	Yes	Deceleration	1995	Yes	Deceleration
Military expenditure (% of GDP)	1997	No	None	1998	No	None
Net Income from Abroad (Current US$)	Model did not converge			2004	No	None
Male age-standardized rates of lung cancer (per 100,000 males)	1998	No	None	Insufficient data		
Female age-standardized rates of lung cancer (per 100,000 females)	1995	No	None	Insufficient data		

Discussion and Conclusion

In general, the data does not support the hypothesis that there was a causal link between the initiation of the MDGs in September 2000 and accelerations in the improvement on MDG indicators. Rather, most of the MDG indicators did not experience accelerations. For the subset of indicators that experienced an acceleration, the acceleration usually started *prior* to the introduction of the MDGs in 2000. Some have proposed that this result is due to the fact that the selection of MDG indicators may have been influenced, in part, by the previously identified indicators that countries were already focusing on and trying to improve prior to 2000. This phenomenon appears prominently in the health MDGs where many of these health indicators have statistically significant accelerations before 2000 and had been part of the global frameworks for health for many years before the 2000 MDG Declaration.

It is possible that there is a causal link in a subset of countries, such as in the sub-Saharan African countries or the countries that were highly supported by external assistance (large ratio of ODA/GDP). Since the sub-Saharan African countries comprise the majority of the IDA-only countries, this type of subset analysis would not be expected to produce an entirely different conclusion.

More broadly, it is important to observe that official development assistance (ODA) comprises only a very minor part of the global economy while broader, global economic trends are likely to have influenced many of the observed changes in the development indicators.

There was a consistent trend in decelerations of the Water, Sanitation and Hygiene (WASH) indicators post 2000 after removing the heavy influence countries. This is concerning since the average values of the indicators is below 100% meaning that the deceleration is not necessarily due to a ceiling effect.

A future research project could entail examining countries that were segmented by ODA/GDP ratio to see if there are differences in the acceleration patterns associated with highly donor-dependent versus less donor-dependent countries. This analysis was not performed in this stage of the study for two reasons: (1) time restrictions and (2) this analysis was developed from the perspective of an external researcher where the primary question was simply “in general, was there an acceleration following the MDG Declaration?” and not the secondary question of “was there a pattern of acceleration as a function of the level of donor-dependence?”

Additional research can examine the individual indicators in detail to understand the programs, activities and policies that were implemented around the acceleration years to see if more information and leading practices can be gleaned regarding which activities likely produced an acceleration in progress.

A few statistical notes appear below regarding validity:

INTERNAL VALIDITY

With regard to internal validity, factors such as selection bias of indicators were controlled for by identifying indicators based on objective criteria such as the availability of data. Within each dataset, we dropped observations based on a quantifiable objective criteria for identifying heavy influence countries (e.g. Cook’s distance >0.3, RLD>5).

However we were unable to control for data quality. For instance, while we made use of annualized data, the data collection was generally not done annually. Many of the data points were constructed by statistical groups based on interpolation and estimation. Our modeling approach takes the input data at face-value, assuming that they are unbiased estimates of the true values. As such, our conclusions may be limited due to the lack of actual measurements. Secondly, the measurement instruments are likely to have changed over time since the computation methods for indicators tend to be revised. In our study, we assumed that the measurement instruments were constant over time, which may not be a valid assumption.

Statistical Validity

We addressed statistical validity concerns by using Bonferroni adjustments for our p-value thresholds to avoid making conclusions based on a chance occurrence of a result that was significant at the 5% level. This adjustment is statistically conservative. We also assessed the quality of fit of our models through different robustness checks, for example examining the pattern and magnitude of residuals, comparing our results with projections, and adding a polynomial term to the regression to examine if our results changed.

The absolute percent deviation tended to be low (less than 5%) for the vast majority of the dataset indicating that for most of the datasets the current functional form is likely sufficient.

We employed log transformations for the predicted variables to reduce the impact of heavy influence countries. Post-transformation, the distribution of the predicted values and the residuals still tended to diverge from a normal distribution. The log transformation tended to have minimal influence on the dataset or conclusions for target variables that were percentages since the untransformed data was already constrained by the acceptable range.

Future studies would also be greatly helped by an increase in data quality and availability – which have formed the major constraints in this study.

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Acknowledgements

The author, Howard Friedman, wishes to acknowledge the following:

(1) The United Nations for providing me the sabbatical time to perform this research, encouraging the distribution and discussion of the research within the UN community through webinars, seminars, videos and UN intranet and for enabling the research to be distributed to the broader global community. Specifically, I wish to recognize the leadership and support from the UNFPA Technical Division (Jacqueline Mahon, Laura Laski, Mona Kaidbey, Bruce Campbell), Human Resources (Arturo Pagan, Michael Emery) and the Office of the Executive Director. Additionally, I would like to recognize the other UN agencies that commented on this report including staff from the World Bank, UNICEF, WHO, and UNDP.
(2) Columbia University for graciously hosting me during my sabbatical.
(3) The research assistance provided by Ms. Boon Pin Tee including identification of databases, writing support and replication of results in STATA
(4) The helpful research discussions/feedback/support from the following:
    - Columbia University: Prof. Chris Blattman, Dean Robert Lieberman, Dean Dan McIntyre, Prof. Moshe Prof. Adler, Prof. Donald Green, Prof. Paul Thurman, Dean Roger Lehecka, Dean Miguel Urquiola, Dean Glen Hubbard, Eva Weissman
    - Center for Global Development: Dr. Michael Clemens, Dr. Todd Moss, Dr. Charles Kenny
    - National Institutes of Health: Dr. William Figg
    - Rutgers University: Prof. Jean-Marc Coincaud
    - City University of New York: Prof. Tom Piskula
    - UN staff members for their helpful suggestions and comments.

Appendix A

MDG Indicator	WB INDICATOR CODE	INDICATOR NAME	NOTES
1.1	SI.POV.DDAY	Poverty headcount ratio at $1.25 a day (PPP) (% of population)	Rejected due to scattered data and missing values.
1.2	SI.POV.GAPS	Poverty gap at $1.25 a day (PPP) (%)	Rejected due to scattered data and missing values.
1.3	SI.DST.FRST.20	Income share held by lowest 20%	Rejected due to scattered data and missing values.
1.7	SL.EMP.VULN.ZS	Vulnerable employment, total (% of total employment)	Rejected due to insufficient countries (less than 10)
1.8	SH.STA.MALN.ZS	Malnutrition prevalence, weight for age (% of children under 5)	Rejected due to scattered data and missing values.
2.1	SE.PRM.NENR	School enrolment, primary (% net)	Rejected due to insufficient countries (less than 10)
2.1	SE.PRM.PRSL.FE.ZS	Persistence to last grade of primary, female (% of cohort)	Rejected due to scattered data and missing values.
2.1	SE.PRM.PRSL.MA.ZS	Persistence to last grade of primary, male (% of cohort)	Rejected due to scattered data and missing values.
2.3A	SE.ADT.1524.LT.FE.ZS	Literacy rate, youth female (% of females ages 15-24)	Rejected due to scattered data and missing values.
2.3B	SE.ADT.1524.LT.MA.ZS	Literacy rate, youth male (% of males ages 15-24)	Rejected due to scattered data and missing values.
3.1A	SE.ENR.PRIM.FM.ZS	Ratio of female to male primary enrolment (%)	Rejected due to insufficient countries (less than 20)
3.1B	SE.ENR.SECO.FM.ZS	Ratio of female to male secondary enrolment (%)	Rejected due to insufficient countries (less than 20)
3.1C	SE.ENR.TERT.FM.ZS	Ratio of female to male tertiary enrolment (%)	Rejected due to scattered data and missing values.
3.2	SL.EMP.INSV.FE.ZS	Share of women employed in the nonagricultural sector (% of total nonagricultural employment)	Rejected due to insufficient countries (less than 20)
5.1	SH.STA.MMRT	Maternal mortality ratio (modelled estimate, per 100,000 live births)	Rejected due to insufficient time points (only 5 available)
5.2	SH.STA.BRTC.ZS	Births attended by skilled health staff (% of total)	Rejected due to scattered data and missing values.
5.3	SP.DYN.CONU.ZS	Contraceptive prevalence (% of women ages 15-49)	Rejected due to scattered data and missing values.
5.5A	SH.STA.ANVC.ZS	Pregnant women receiving prenatal care (%)	Rejected due to scattered data and missing values.
5.6	SP.UWT.TFRT	Unmet need for contraception (% of married women ages 15-49)	Rejected due to scattered data and missing values.

6.6A	SH.MLR.INCD	Notified cases of malaria (per 100,000 people)	Rejected due to insufficient time points (only 1 available)
7.1	AG.LND.FRST.ZS	Forest area (% of land area)	Rejected due to insufficient time points (only 4 available)
8.15	IT.CEL.SETS.P2	Mobile cellular subscriptions (per 100 people)	Rejected due to concerns over data quality
8.16	IT.NET.USER.P2	Internet users (per 100 people)	Rejected due to concerns over data quality

Appendix B

WB INDICATOR CODE	INDICATOR NAME	NOTES
SE.SEC.DURS	Secondary education, duration (years)	Reject as secondary education duration is likely impacted by the MDG Target 2A (primary education) and Target 3A (eliminating gender disparity in primary and secondary education)
SE.PRM.DURS	Primary education, duration (years)	Reject as likely impacted by the MDG Target 2A (universal primary education)
SE.PRM.AGES	Primary school starting age (years)	Reject as likely impacted by the MDG Target 2A (universal primary education)
SE.SEC.AGES	Secondary school starting age (years)	Reject as likely impacted by the MDG Target 2A (universal primary education)
SP.DYN.LE00.FE.IN	Life expectancy at birth, female (years)	Rejected as life expectancy is strongly determined by infant mortality rates.
SP.DYN.LE00.MA.IN	Life expectancy at birth, male (years)	Rejected as life expectancy is strongly determined by infant mortality rates.
SP.DYN.LE00.IN	Life expectancy at birth, total (years)	Rejected as life expectancy is strongly determined by infant mortality rates.
AG.LND.CREL.HA	Land under cereal production (hectares)	Rejected as it is closely related to crop production.
AG.YLD.CREL.KG	Cereal yield (kg per hectare)	Rejected as it is closely related to crop production.
AG.PRD.LVSK.XD	Livestock production index (2004-2006 = 100)	Rejected as it is closely related to food production.
AG.PRD.CREL.MT	Cereal production (metric tons)	Rejected as it is closely related to crop production.
DT.DFR.DPPG.CD	Debt forgiveness or reduction (current US$)	Rejected as it is closely related to debt service.
BN.KLT.DINV.CD	Foreign direct investment, net (BoP, current US$)	Rejected as it is closely related to FDI inflows (% of GDP).
NE.CON.PRVT.KN	Household final consumption expenditure (constant LCU)	Rejected as it is closely related to household final consumption expenditure (constant USD)
MS.MIL.TOTL.P1	Armed forces personnel, total	Rejected as it is closely related to armed forces personnel (% of total labour force)
MS.MIL.XPND.CN	Military expenditure (current LCU)	Rejected as it is closely related to military expenditure (% of GDP)

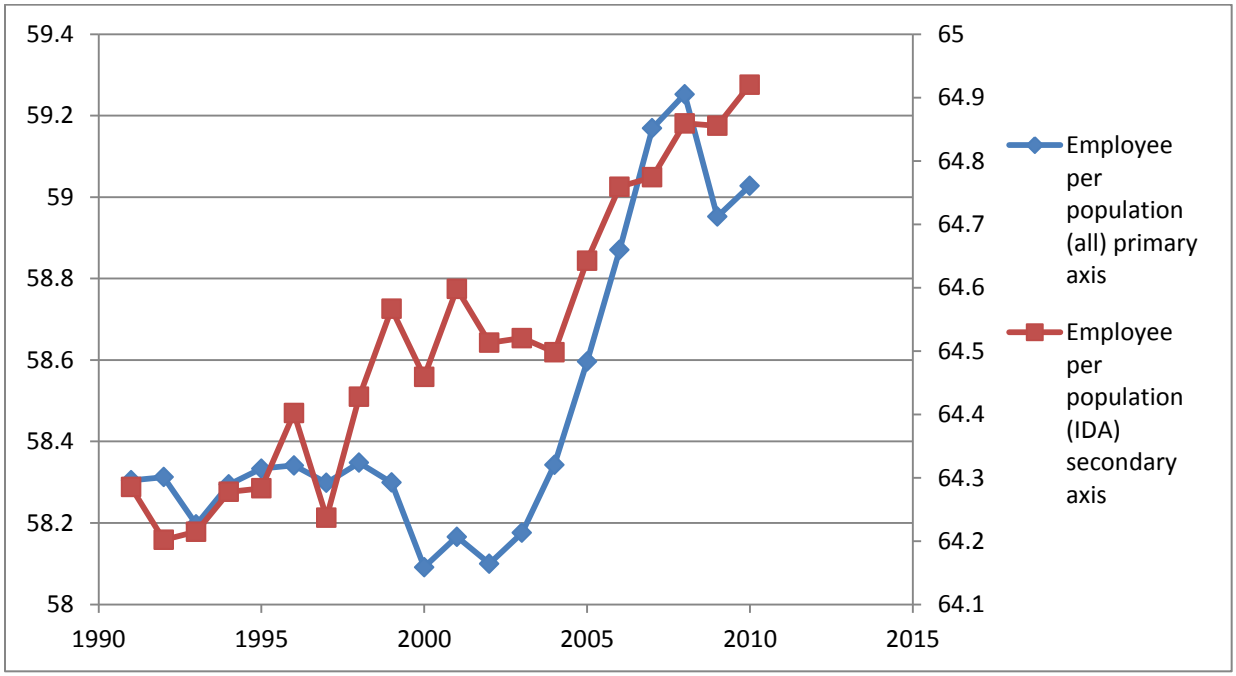
Appendix C:

Target 1B Indicator Employment-to-population ratio

Conclusion: While the IDA only countries did not experience an acceleration or deceleration in the employment-to-population ratio, the set of IDA, IBRD and Blend countries (after removing heavy influence countries) experienced an acceleration in the ratio starting around 2001. Visual inspection suggests that additionally there was a deceleration in the IDA, IBRD and Blend dataset starting around 2008, a likely reflection of the global financial crisis.

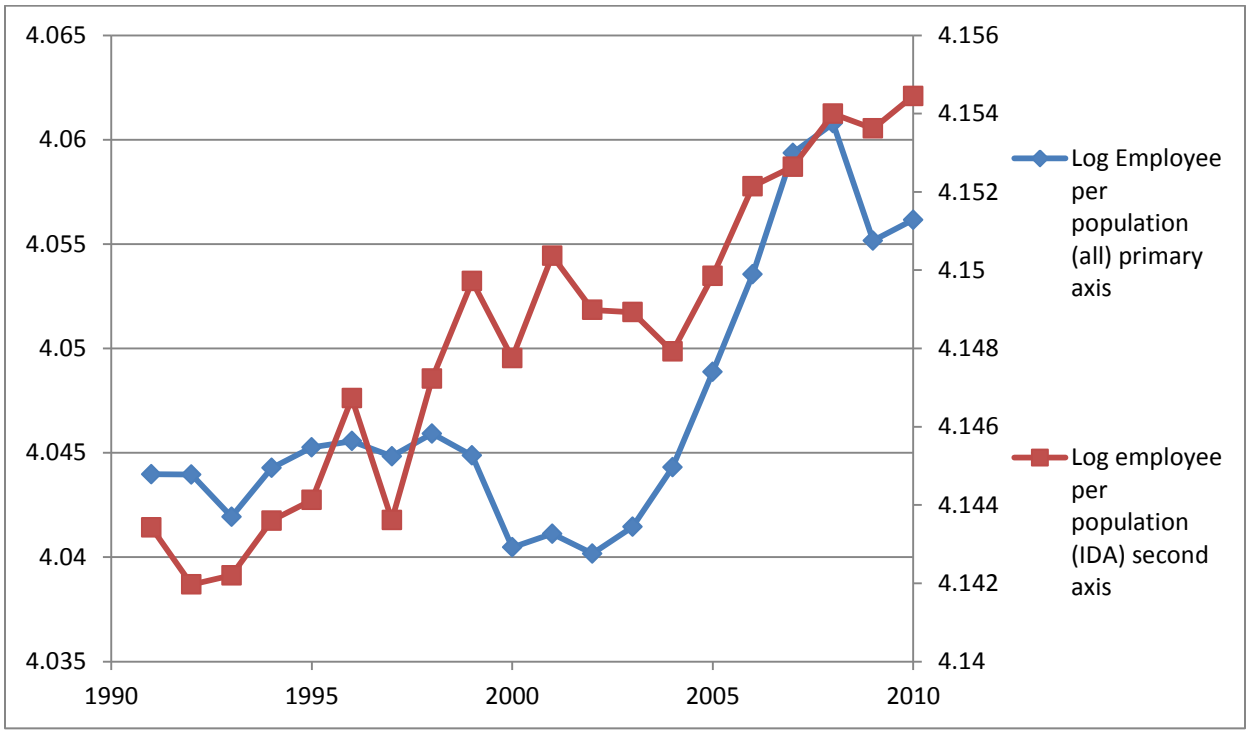
Non-transformed data:

The employee per population curve for IDA only countries is noisy. For all countries (IDA, IBRD, Blend) the curve seems show a change in slope around 2002 (increasing) and then a second change in slope (decreasing) around 2008 (likely due to the global financial crisis).



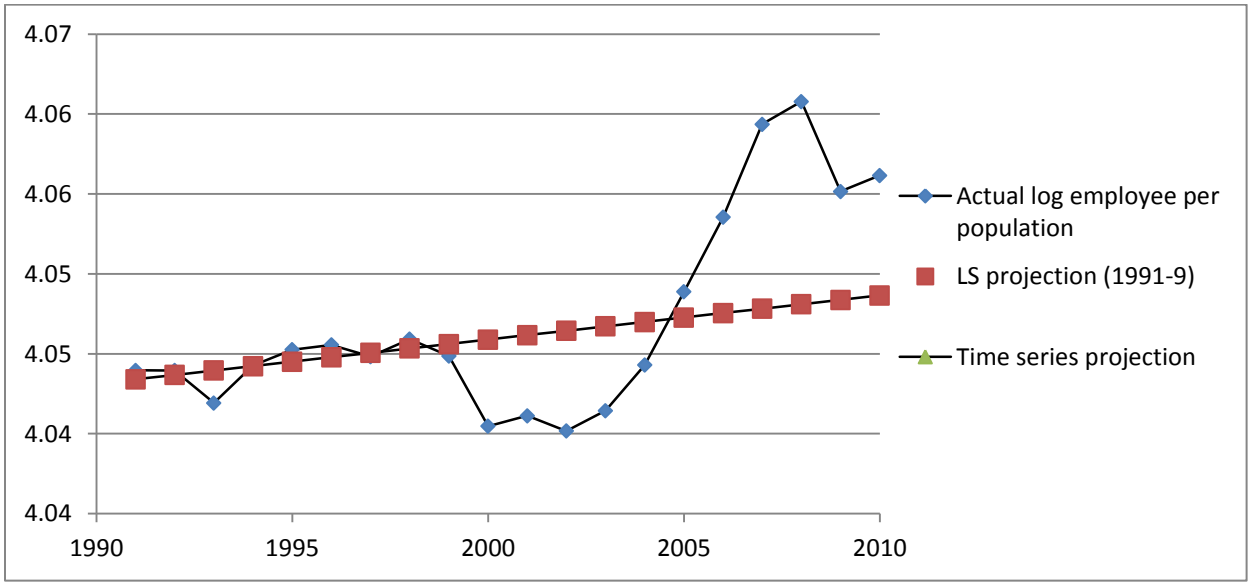
Transformed data:

The employee per population curve for IDA only countries is noisy. For all countries (IDA, IBRD, Blend) the curve seems show a change in slope around 2002 (increasing) and then a change in slope (decreasing) around 2008 (likely due to the global financial crisis).



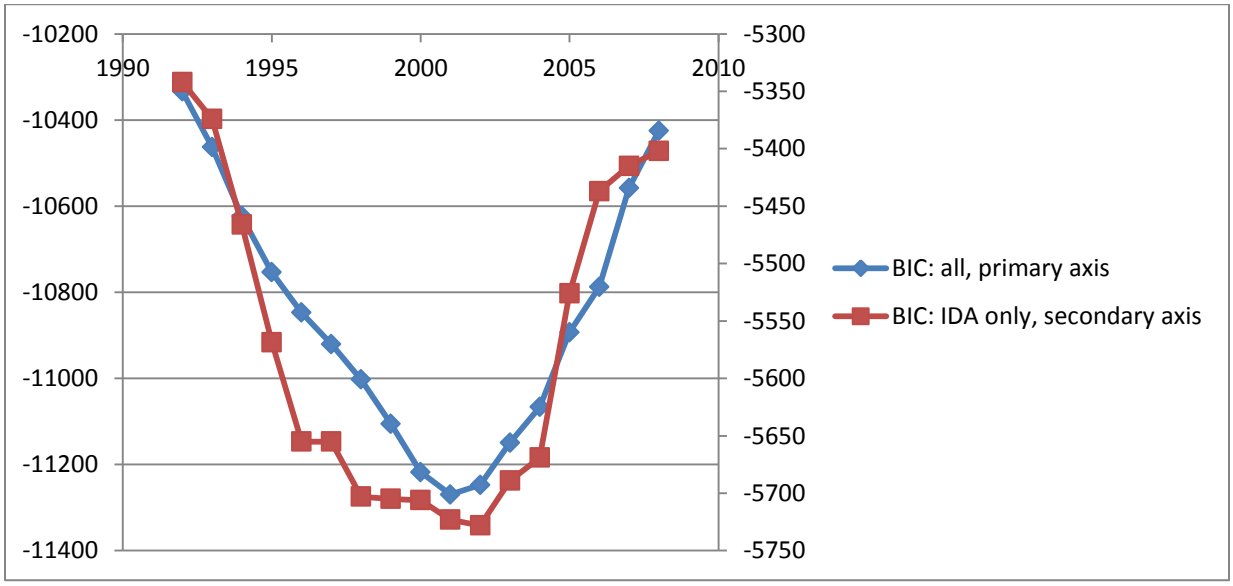
Transformed data: Comparison to time series and least squares regression

Visual inspection of the IDA, IBRD and Blend countries (including heavy influence countries) compared with the time series and least squares projection clearly suggests that there was a shift in the time series throughout the time period of interest.



BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.

The optimal year for an interruption in the time series was clearly around 2001 for the complete dataset (IDA, IBRA, Blend) but for the IDA only the optimal year is less clear.



Estimated coefficients from linear mixed model for optimal year.

IDA, IBRD, Blend countries:

Year: 2001

β_2 (interrupted intercept): -0.00443 (p= 0.2141)

β_3 (interrupted slope): 0.002364 (p=0.0114)

IDA only countries:

Year: 2002

β_2 (interrupted intercept): -0.00278 (p=0.3841)

β_3 (interrupted slope): 0.000087 (p=0.9152)

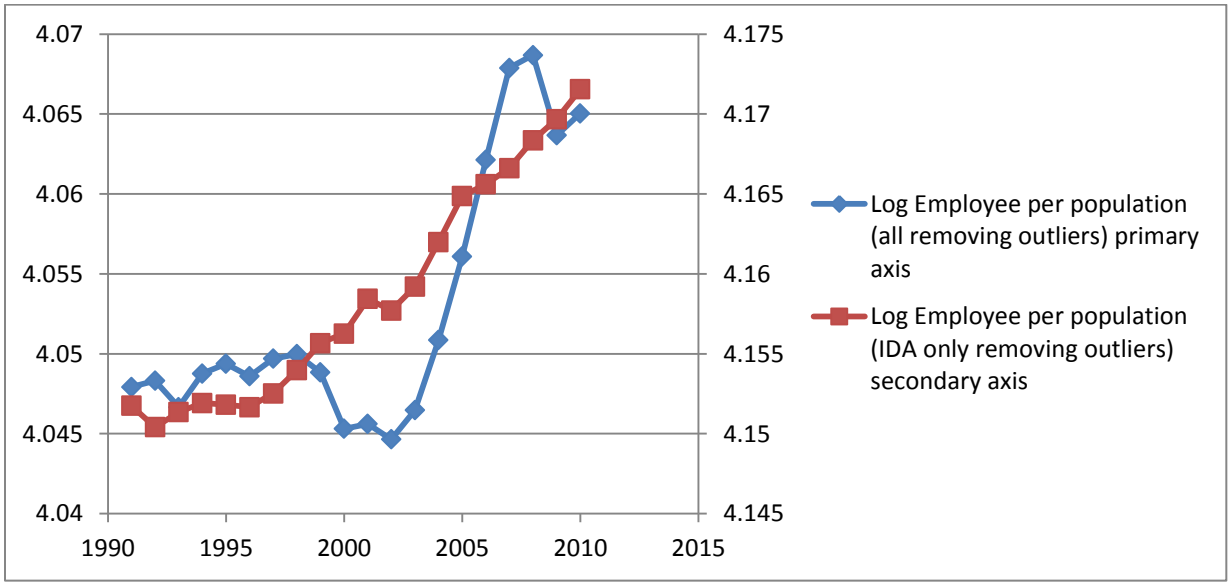
Heavy Influence Countries Identified:

IBRD, Blend, IDA: Bosnia and Herzegovina, Lesotho, Moldova

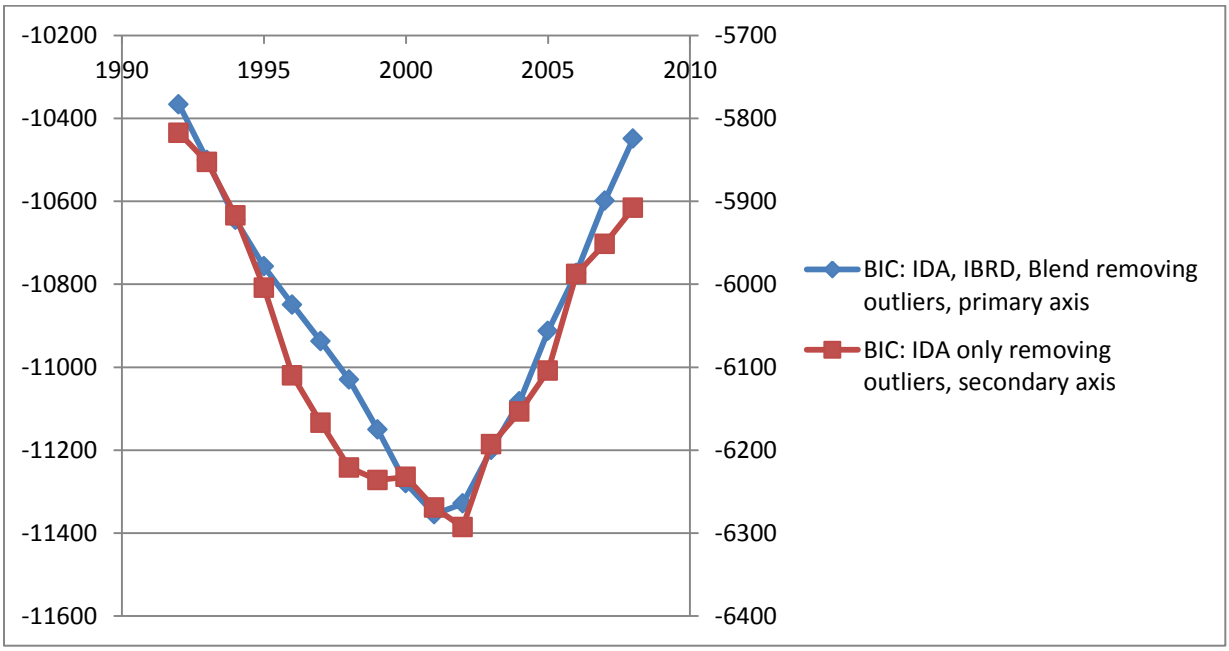
IDA Only: Honduras, Lesotho, Moldova

Transformed data (heavy influence countries removed):

After removing heavy influence countries, the employee per population curve for IDA only countries is no longer noisy but also appears like a fairly straight line with little suggestion of an acceleration. For all countries (IDA, IBRD, and Blend) the curve shows a clear acceleration starting around 2002 (increasing) and then a change in slope (decreasing) around 2008 (likely due to the global financial crisis).



BIC as a function of interrupted year: Log transformed removing heavy influence countries shows a clear minimum around 2001/2002



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

IDA, IBRD, Blend countries:

Year: 2001

β_2 (interrupted intercept): -0.00417 (p=0.2526)

β_3 (interrupted slope): 0.002893 (p=0.0013)

IDA only countries:

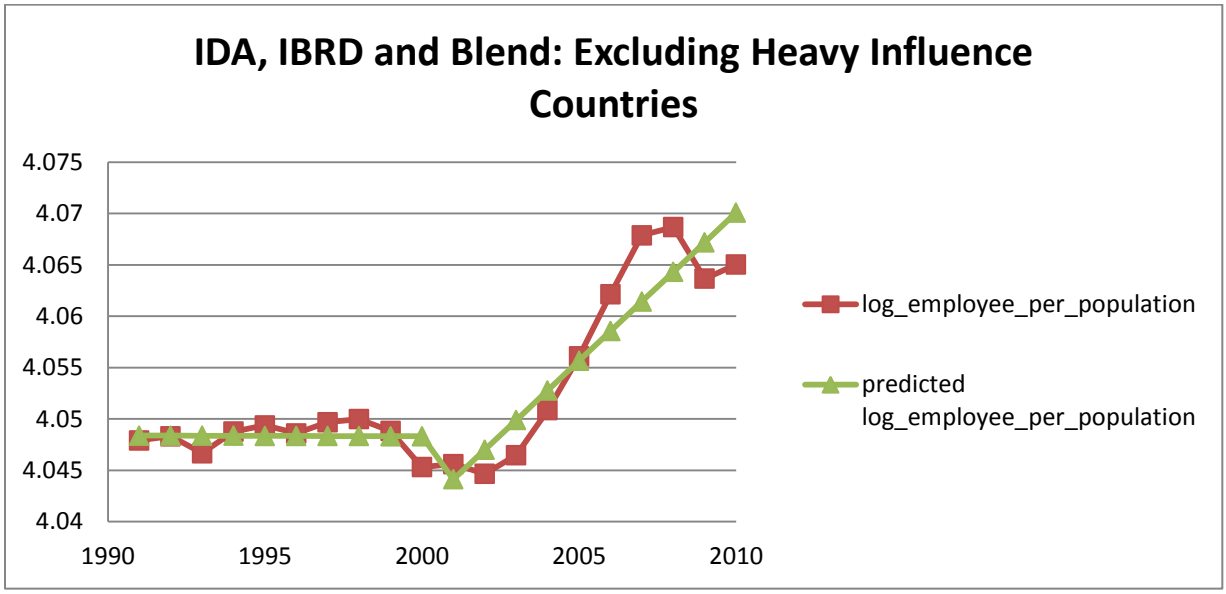
Year: 2002

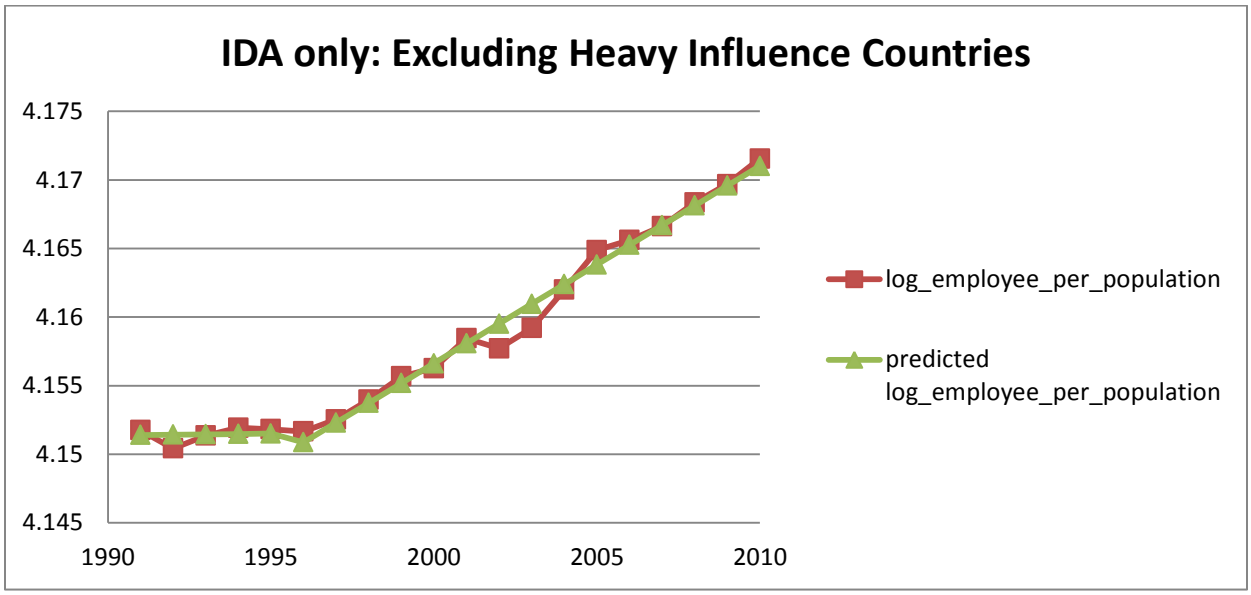
β_2 (interrupted intercept): 0.000503 (p=0.8389)

β_3 (interrupted slope): 0.001028 (p=0.0775)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

The overall model fit for both the IDA, IBRD and Blend dataset as well as the IDA only dataset was good with the absolute percent deviation less than 1%.





Adding Non-Linear Fixed Effect:

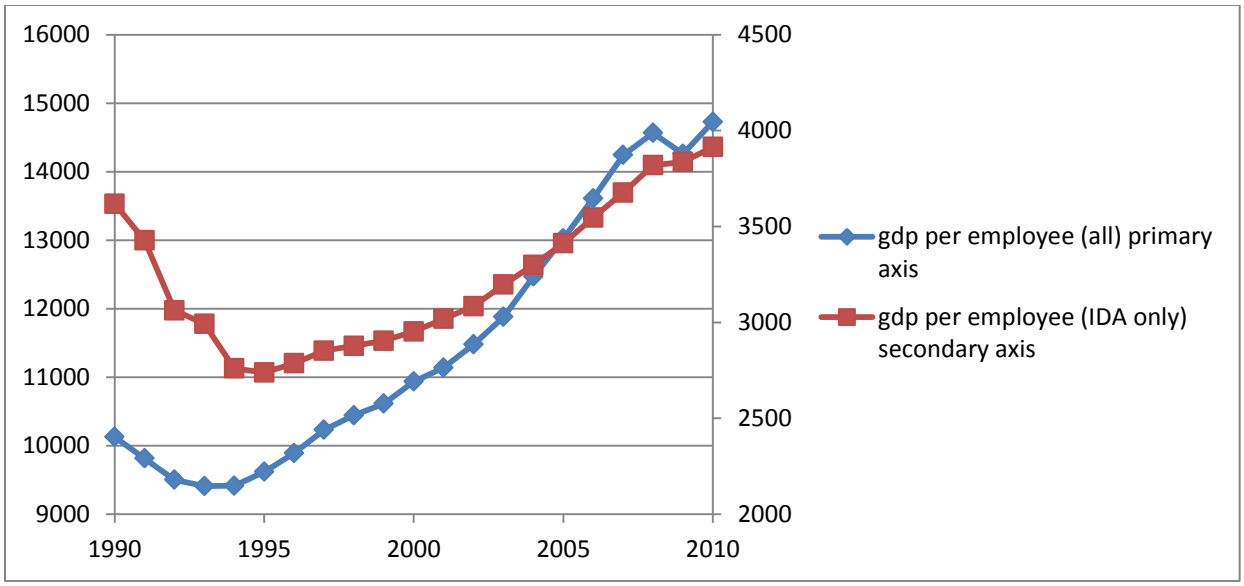
Conclusions from datasets excluding heavy influence countries were unchanged when the fixed effect of year^2 was added to the model.

Target 1B Indicator GDP per person employed

Conclusion: For both the IDA, IBRD, and Blend dataset and the IDA only dataset, there was a clear interruption in the time series starting around 1996 with a sharp increase in the GDP per person employed beginning at that time and continuing up to 2010.

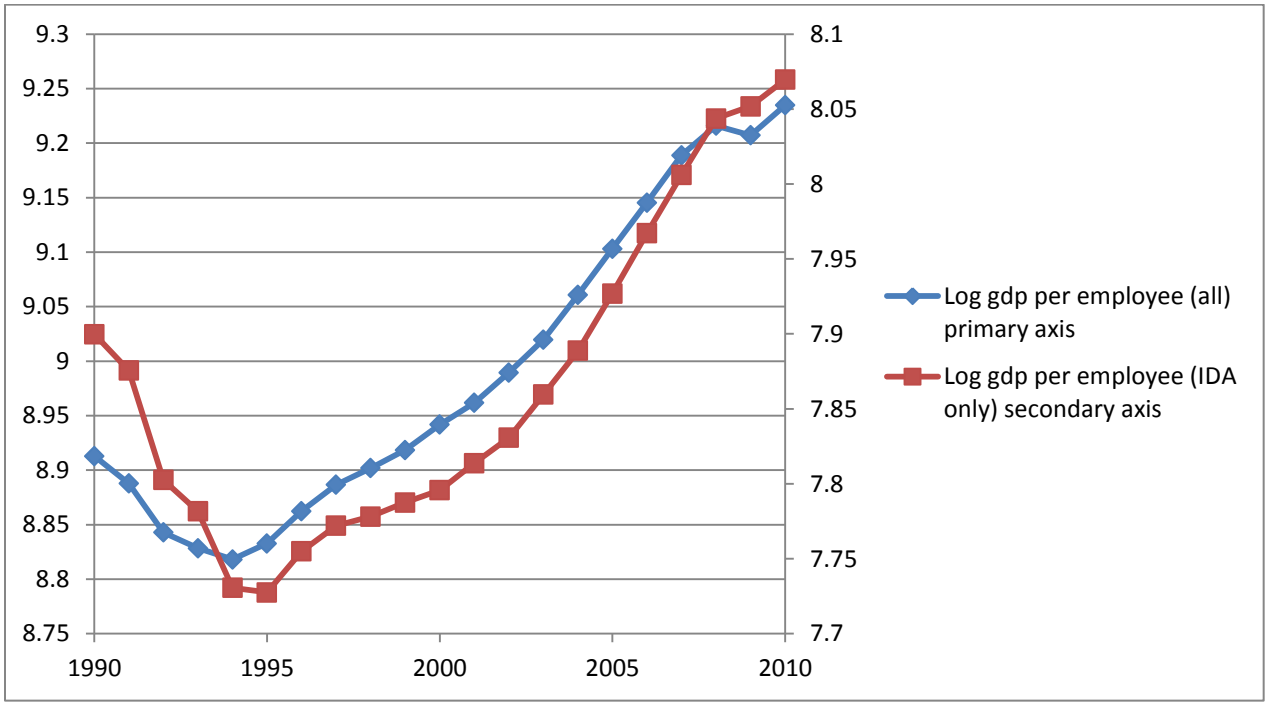
Non-transformed data:

The non-transformed data shows a clear changepoint in the GDP per employee for the IDA only around 1995, while for the IDA, IBRD and Blend the changepoint appears to be a little earlier, possibly 1994.



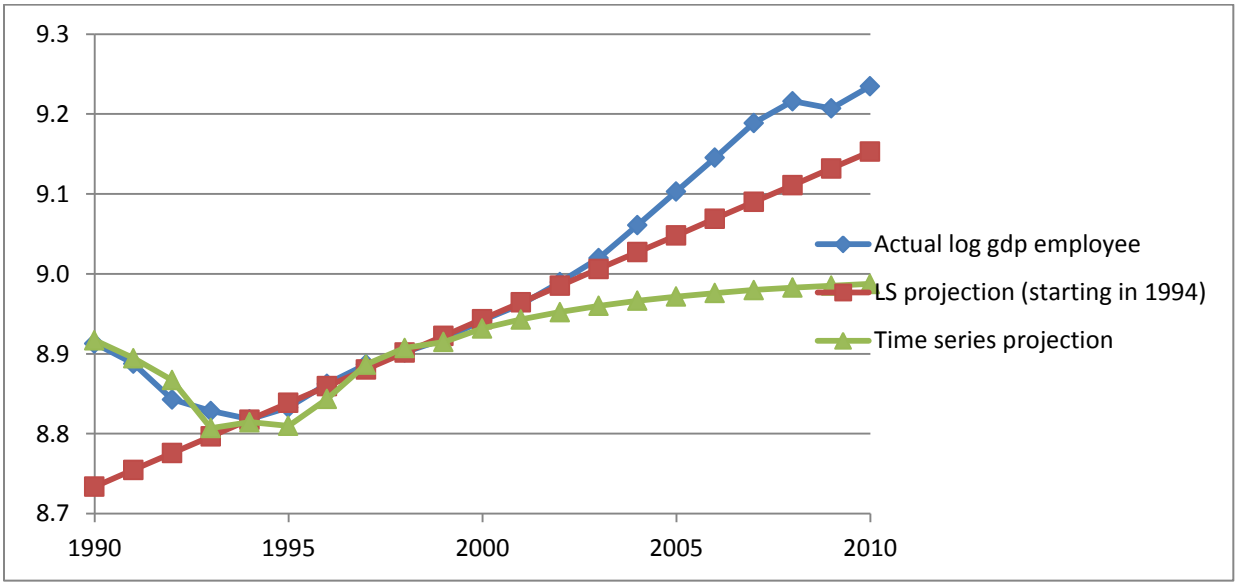
Transformed data:

The transformed data shows a clear changepoint in the GDP per employee for the IDA only around 1995, while for the IDA, IBRD and Blend dataset the changepoint appears to be a little earlier, possibly 1994.



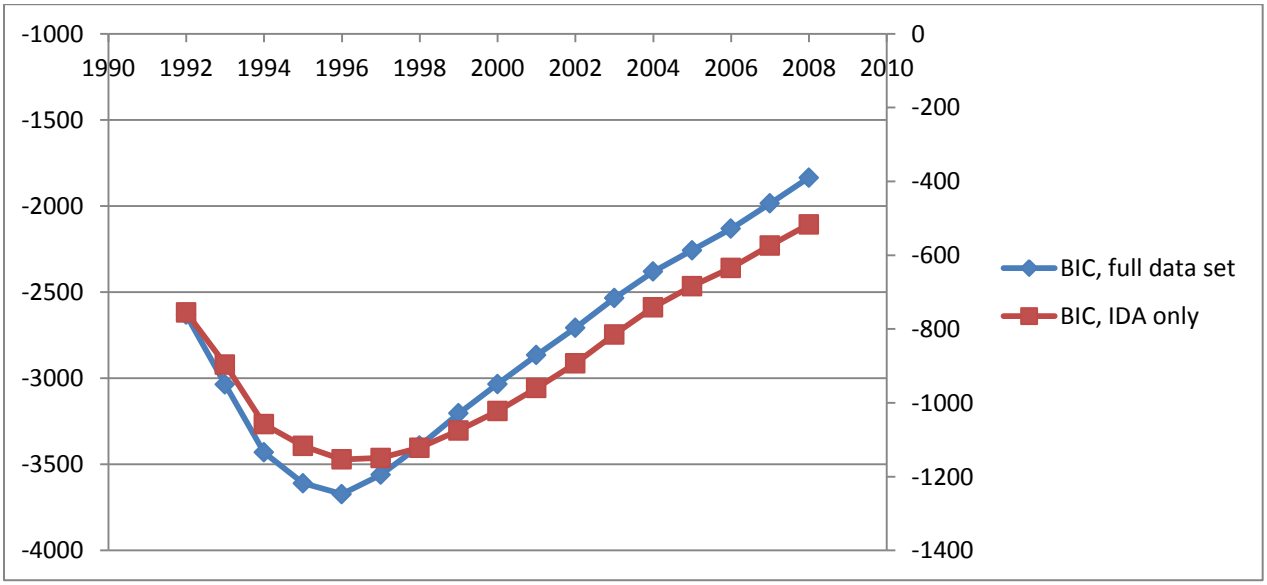
Transformed data: Comparison to time series and least squares regression

Visual inspection of the IDA, IBRD and Blend countries (including heavy influence countries) compared with the time series (using input of 1990-1999) and least squares projection (input 1994-1999) shows clearly that the actual data differs dramatically from the time series and least squares projections supporting the idea that there was a changepoint.



BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.

Both the IDA, IBRD and Blend dataset and the IDA only dataset had clear minimums around 1996, agreeing with visual inspection that a changepoint happened around that time.



Estimated coefficients from linear mixed model for optimal year.

IDA, IBRD, Blend countries:

Year: 1996

β_2 (interrupted intercept): 0.0475 (p = 0.0022)

β_3 (interrupted slope): 0.04693 (p<0.0001)

IDA only countries:

Year: 1996

β_2 (interrupted intercept): 0.04645 (p =0.0018)

β_3 (interrupted slope): 0.06221 (p<0.0001)

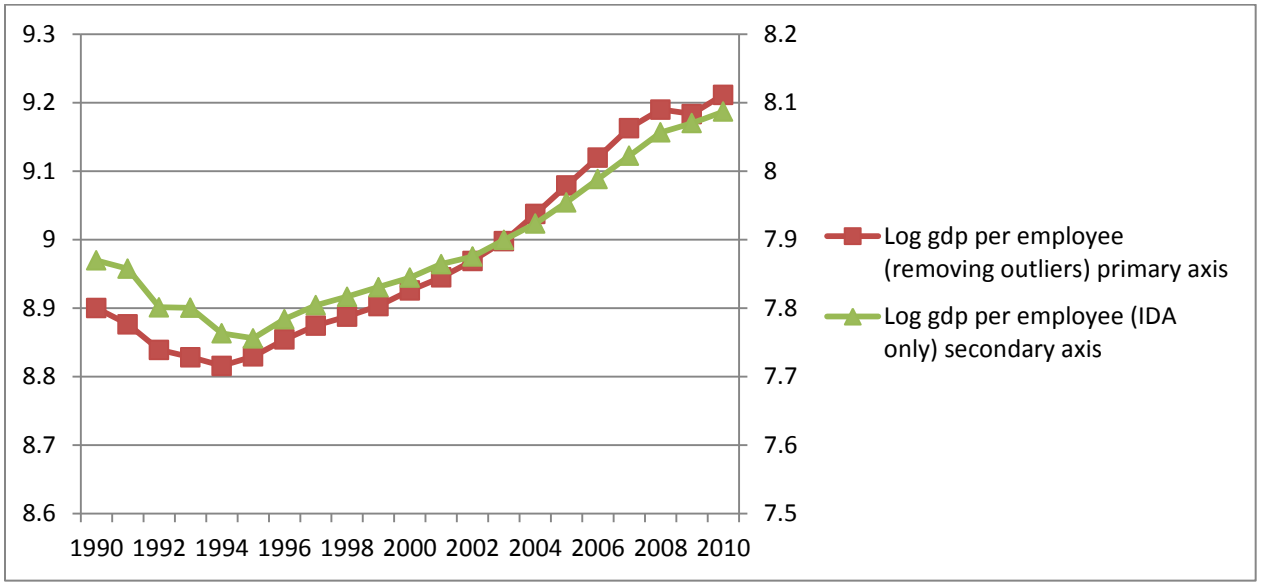
Heavy Influence Countries Identified:

IBRD, Blend, IDA: Armenia, Bosnia and Herzegovina

IDA Only: Angola, Congo, Dem. Rep., Moldova

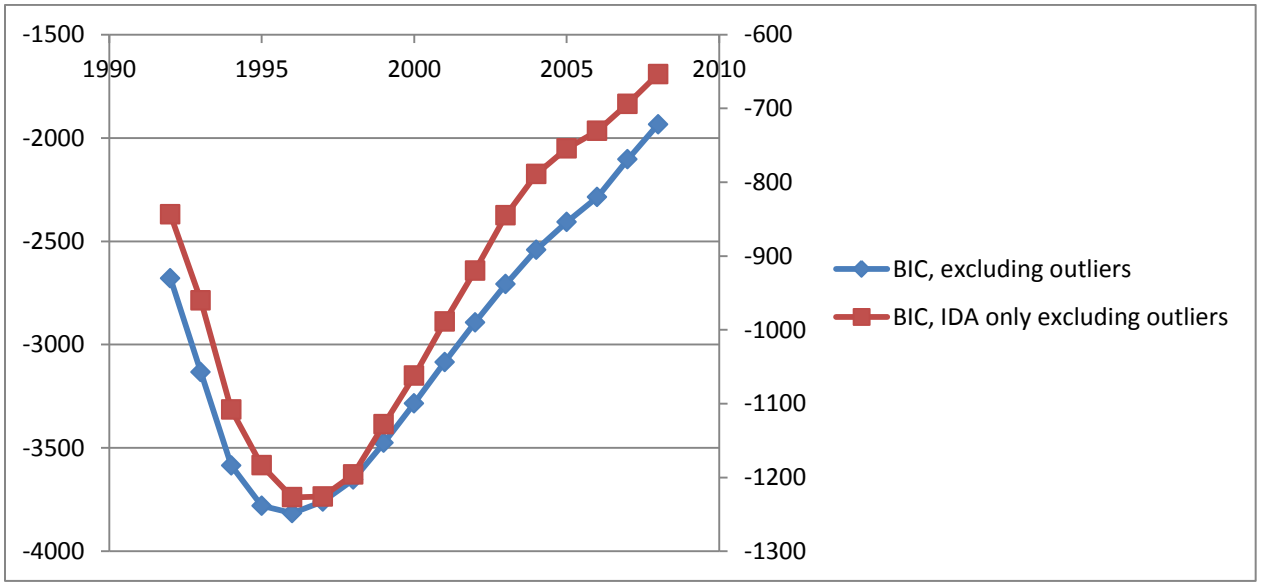
Transformed data (heavy influence countries removed):

After removing heavy influence countries, the changepoints for the IDA, IBRD and Blend and the IDA only datasets appear to be slightly earlier (approximately 1995) based on visual inspection as compared to the datasets with heavy influence countries included.



BIC as a function of interrupted year: Log transformed removing heavy influence countries

Both the IDA, IBRD and Blend dataset and the IDA only dataset had minimums around 1996, agreeing with visual inspection that a changepoint happened around that time.



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

IDA, IBRD, Blend countries:

Year: 1996

β_2 (interrupted intercept): 0.0335 (p=0.0032)

β_3 (interrupted slope): 0.04351 (p<0.0001)

IDA only countries:

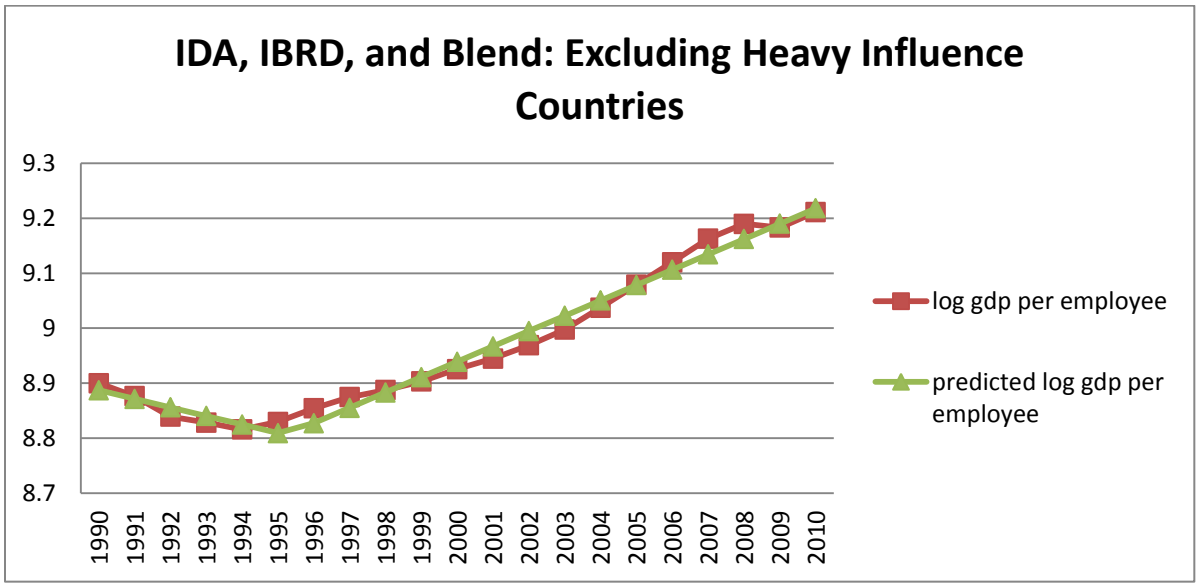
Year: 1996

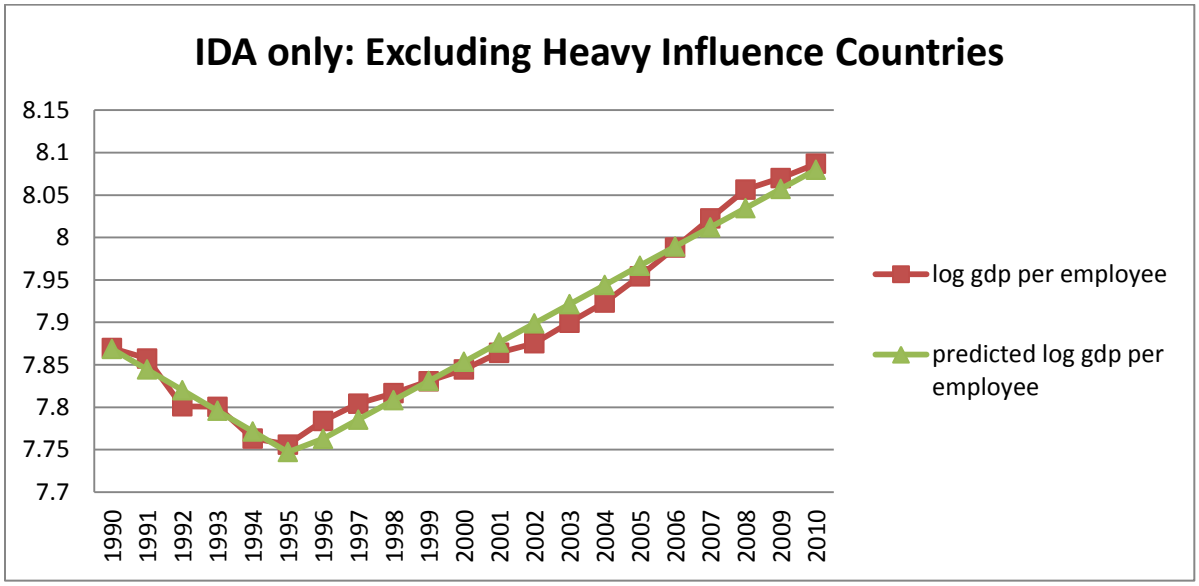
β_2 (interrupted intercept): 0.04009 (p = 0.0066)

β_3 (interrupted slope): 0.04698 (p=0.0002)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

The overall model fit for both the IDA, IBRD and Blend dataset as well as the IDA only dataset was good with the absolute percent deviation less than 1%.





Adding Non-Linear Fixed Effect:

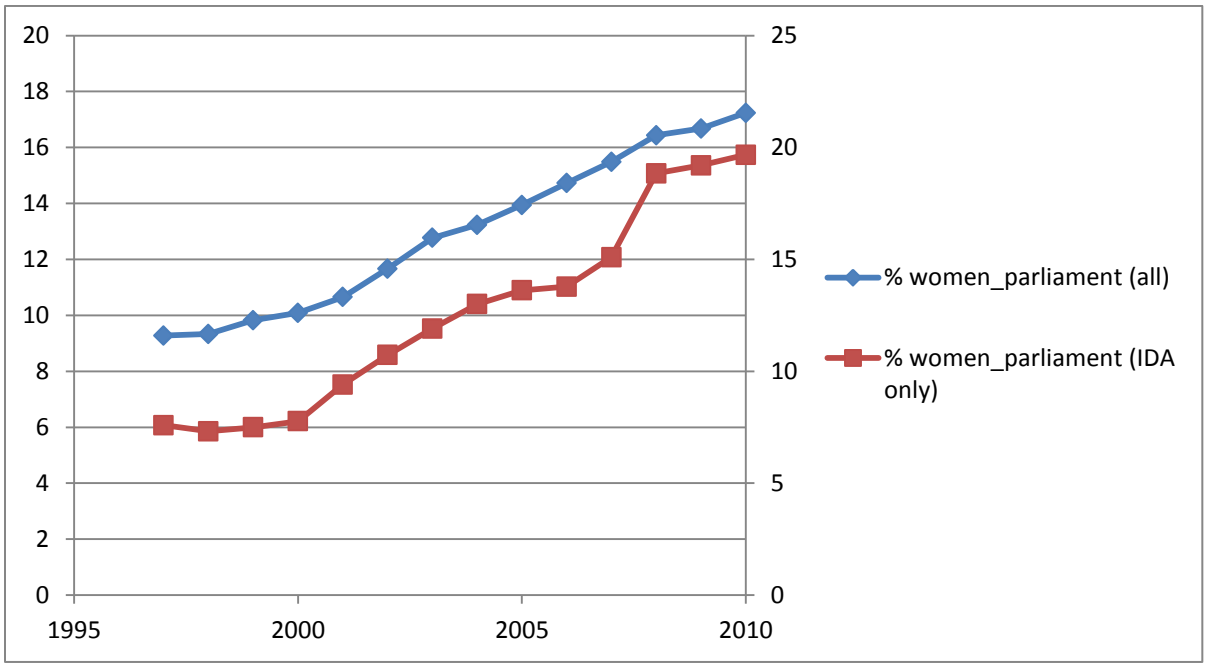
When the fixed effect of year^2 was added to the model for the datasets (excluding heavy influence countries), the interrupted intercept was statistically significant and positive but the interrupted slope was no longer significant. This is a reflection of the fact that the curve itself appears parabolic so the year^2 term captures the shape of the interrupted slope.

Target 3A Indicator Percent Women in Parliament

Conclusion: There was no acceleration or deceleration during the observation time period of 1997 to 2010.

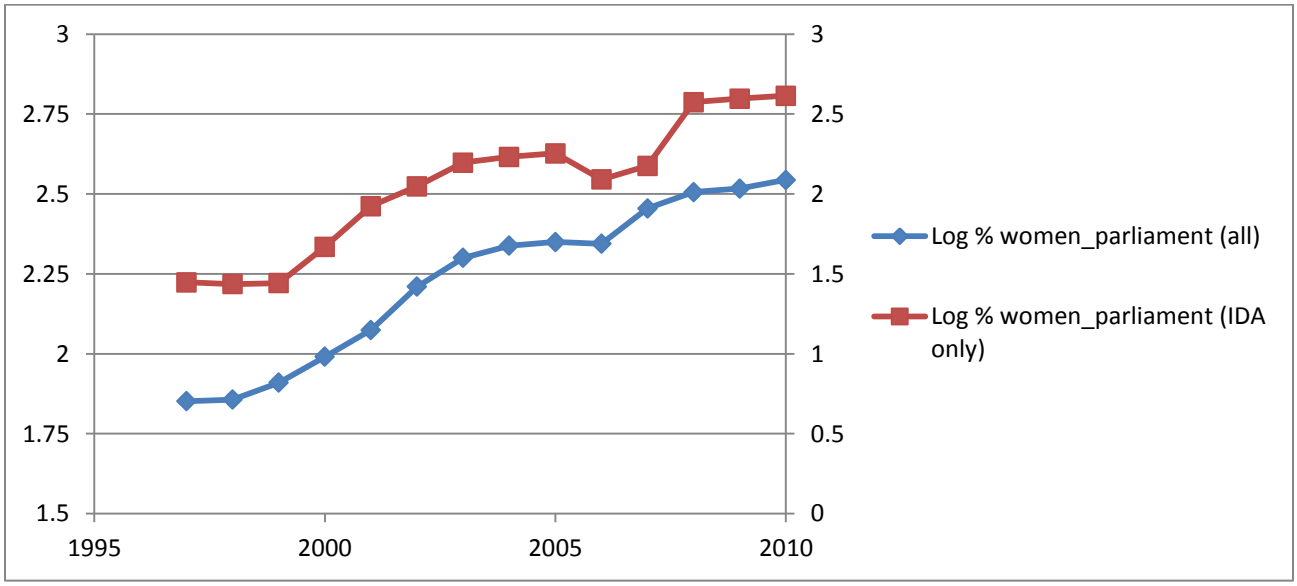
Non-transformed data:

There is no obvious changepoint in the non-transformed data for the larger dataset (IDA, IBRD and Blend) but there may be a step shift (interrupted intercept) around 2007 in the IDA only dataset.



Transformed data:

There is no obvious changepoint in the non-transformed data for the larger dataset (IDA, IBRD and Blend) but there may be a step shift (interrupted intercept) around 2007 in the IDA only dataset.

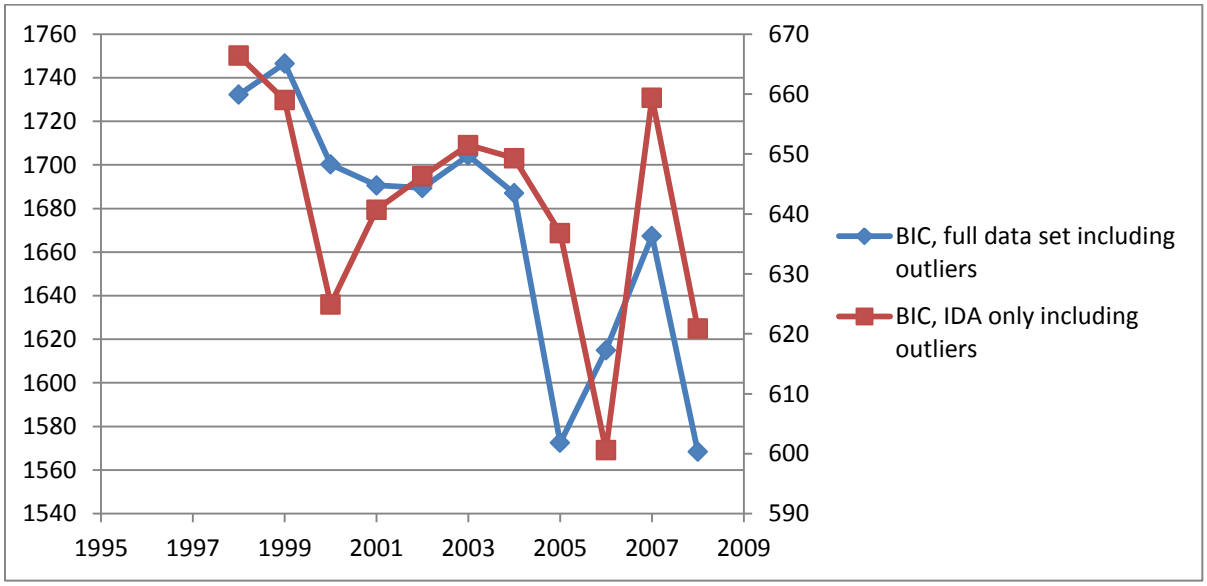


Transformed data: Comparison to time series and least squares regression

Because the time series starts in 1997, there are not enough data points to develop a time series for the time period before 2000.

BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.

The pattern of the BIC shows that there was no clear minimum for the full dataset (2005 and 2008 similar BIC minimums). For the IDA only dataset, the BIC minimum was in 2006 but again the pattern was not clear compared to other datasets.



Estimated coefficients from linear mixed model for optimal year.

IDA, IBRD, Blend countries:

Year: 2008

β_2 (interrupted intercept): -0.03111 (p= 0.8063)

β_3 (interrupted slope): -0.03849 (p=0.2732)

IDA only countries:

Year: 2006

β_2 (interrupted intercept -0.3659 (p= 0.8455)

β_3 (interrupted slope): 0.037 (p= 0.6249)

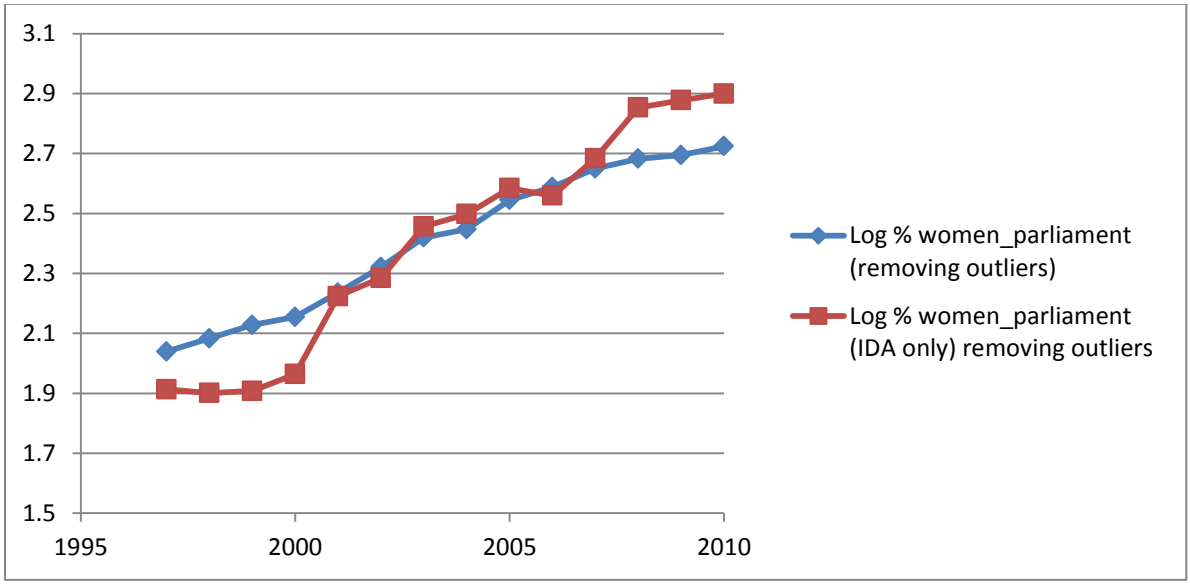
Heavy Influence Countries Identified:

IBRD, Blend, IDA: Belize, Jordan, Kiribati, Kyrgyz Republic, Micronesia, Fed. Sts., St. Kitts and Nevis

IDA Only: Kiribati, Kyrgyz Republic, Micronesia, Fed. Sts.

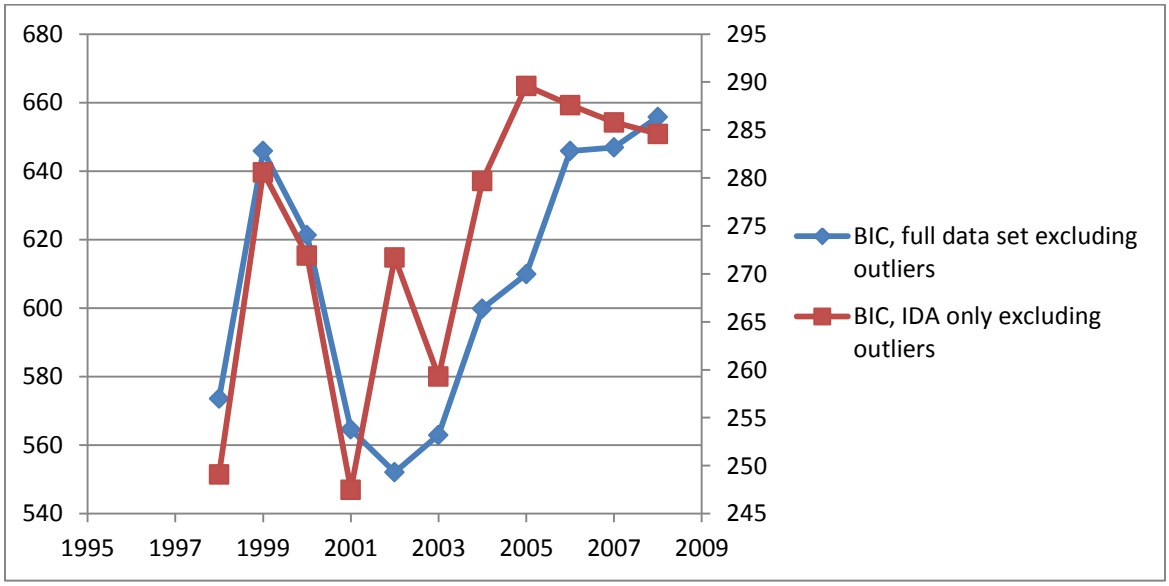
Transformed data (heavy influence countries removed):

After removing heavy influence countries, there is no obvious changepoint in the transformed datasets.



BIC as a function of interrupted year: Log transformed removing heavy influence countries

Both the IDA, IBRD and Blend dataset and the IDA only dataset exhibit multiple years that are possible minimums for BIC.



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

IDA, IBRD, Blend countries:

Year: 2002

β_2 (interrupted intercept): 0.08188 (p= 0.1933)

β_3 (interrupted slope): -0.0016 (p=0.9408)

IDA only countries:

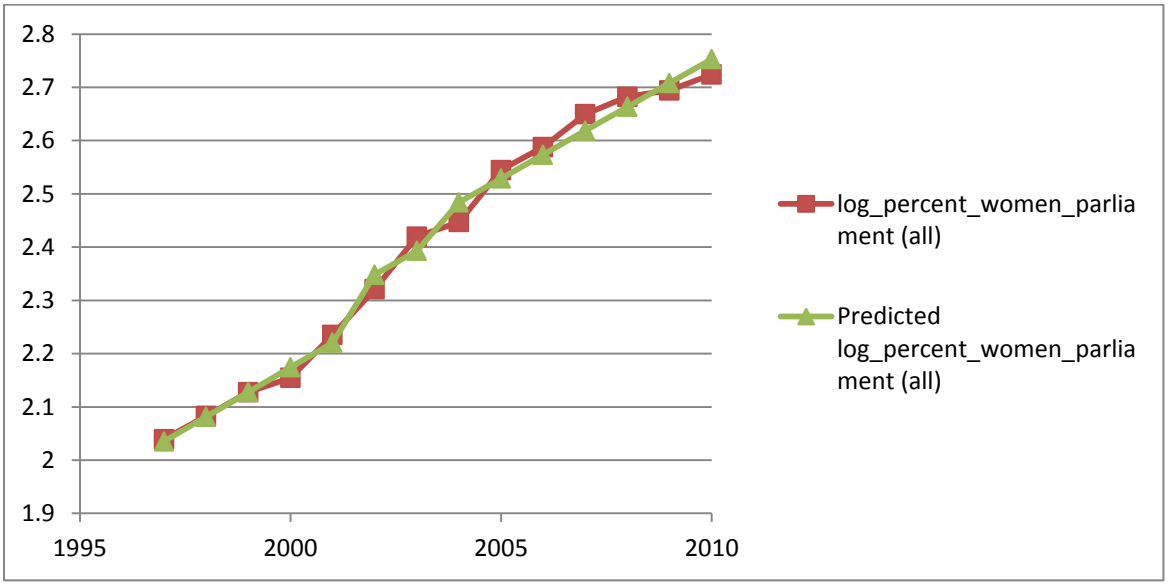
Year: 2003

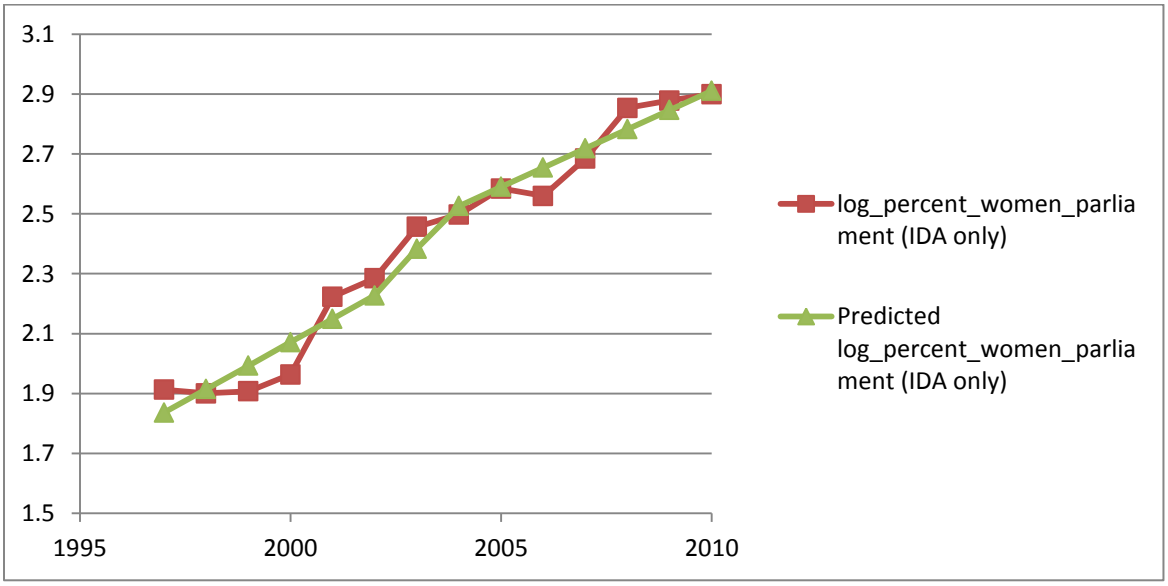
β_2 (interrupted intercept): 0.07776 (p=0.3638)

β_3 (interrupted slope): -0.01407 (p=0.7229)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

Overall the data was well fit by the model with the absolute percent deviation generally less than 5%.





Adding Non-Linear Fixed Effect:

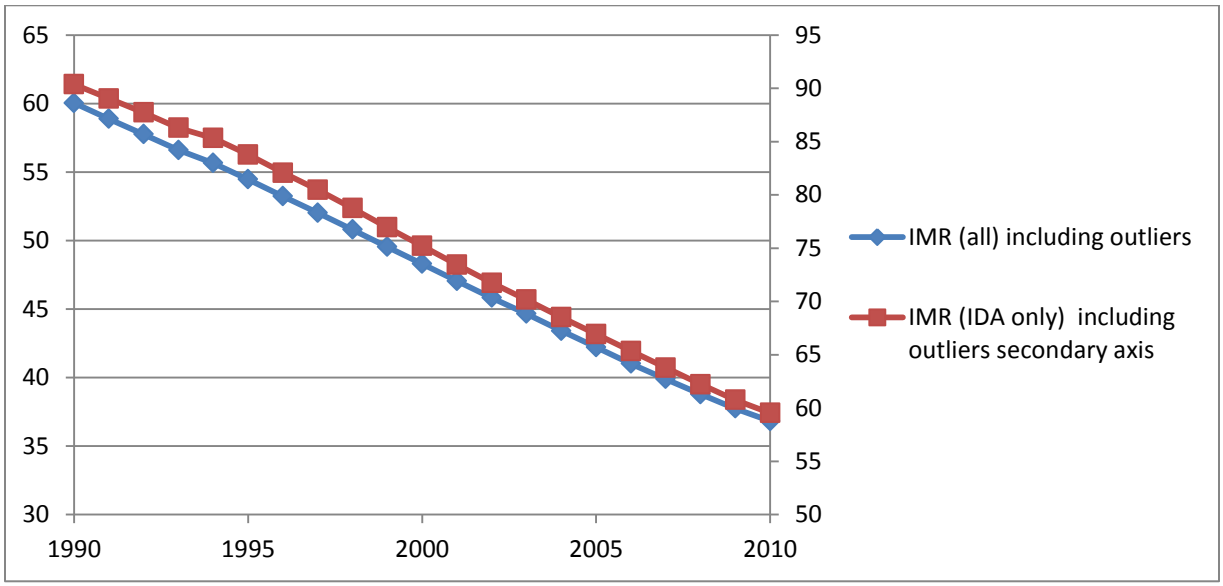
When the fixed effect of year^2 was added to the model for the datasets (excluding heavy influence countries) there was no change in the conclusions.

Target 4A Indicator Infant mortality rate

Conclusion: All analysis datasets (IDA, IBRD, and Blend; IDA only) with and without heavy influence countries demonstrated an acceleration in the decline of infant mortality rate shortly before 2000.

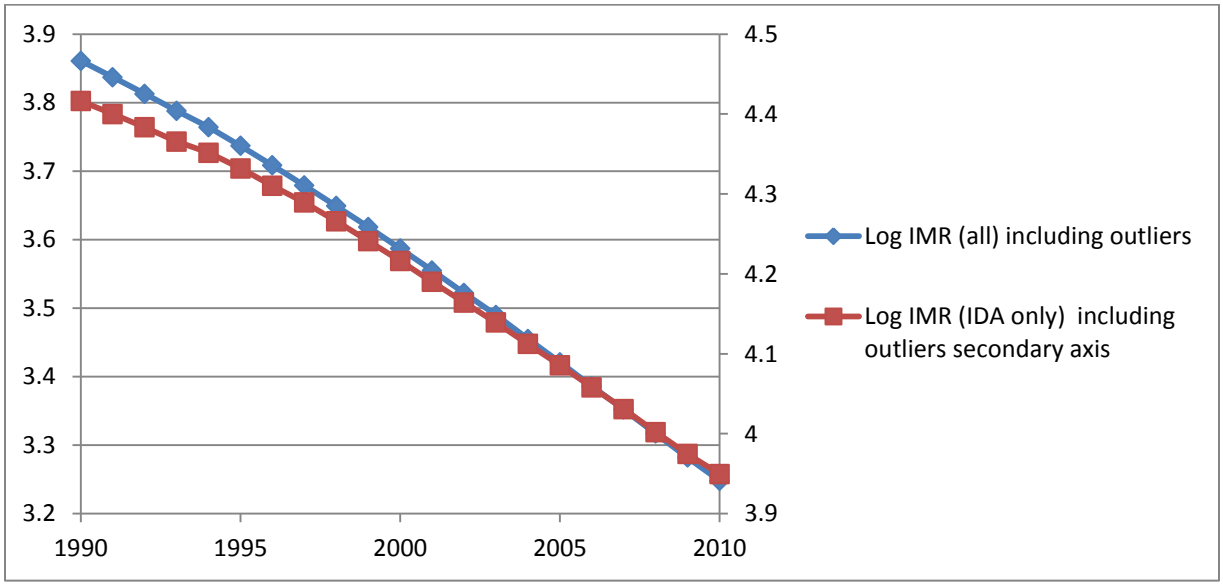
Non-transformed data:

There is no obvious changepoint in the non-transformed data for the larger dataset (IDA, IBRD and Blend) or the IDA only. The data looks extremely linear and the smoothness of the curve raises concerns that the input data points are largely model derived.



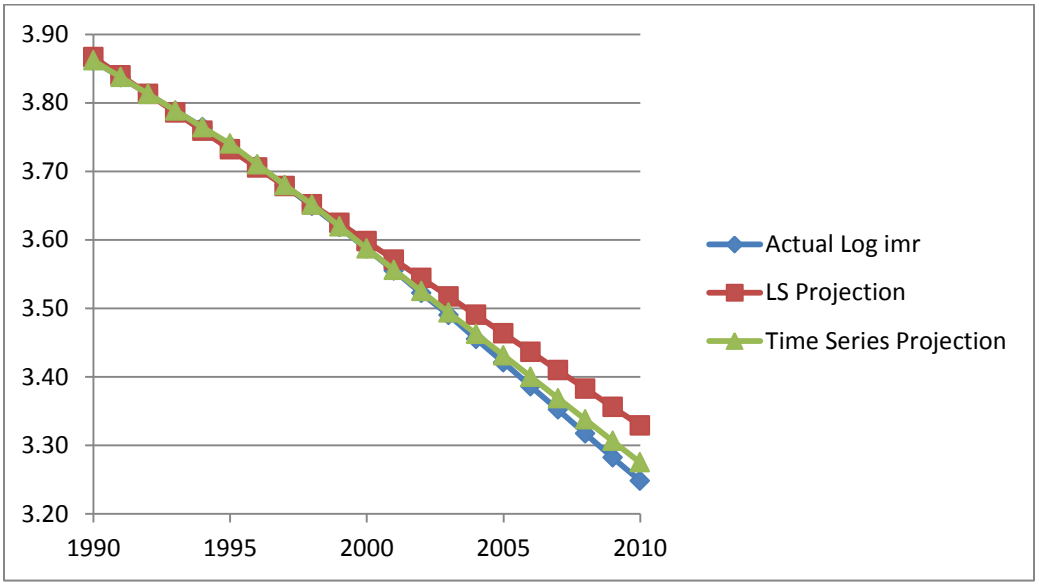
Transformed data:

Both the IDA, IBRD, and Blend dataset and the IDA only dataset appear to have some acceleration around 1999 but the acceleration is slight. More broadly, the smoothness of the curves (lack of noise) raises concerns that the baseline data may be more model generated than actual observations.



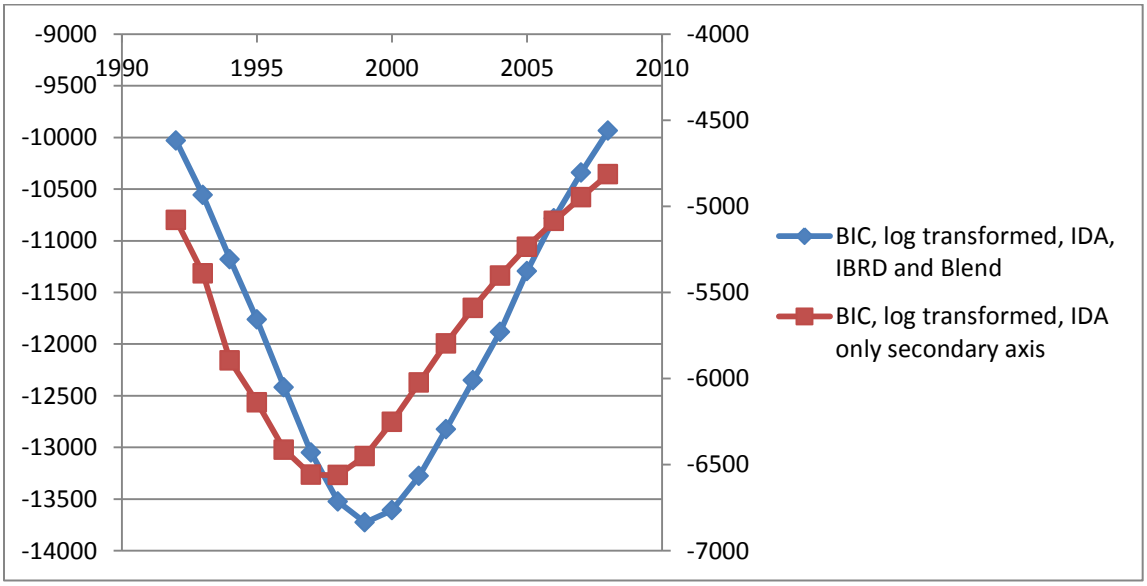
Transformed data: Comparison to time series and least squares regression

The linear regression mode shows clearly the variance between the trend in 1990-1999 and the overall dataset. The time series projection (which uses 1990-1999 as input data) corresponded well to the actual data for the entire time period 1999-2010.



BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.

The pattern of the BIC shows that there was a clear minimum in the IDA, IBRD and Blend dataset around 1999 while the minimum for the IDA only dataset was slightly earlier (1997,1998).



Estimated coefficients from linear mixed model for optimal year.

IDA, IBRD, Blend countries:

Year: 1999

β_2 (interrupted intercept): -0.00581 (p= 0.0776)

β_3 (interrupted slope): -0.0776 (p<0.0001)

IDA only countries:

Year: 1998

β_2 (interrupted intercept: -0.00609 (p= 0.0643)

β_3 (interrupted slope): -0.00861 (p=0.0002)

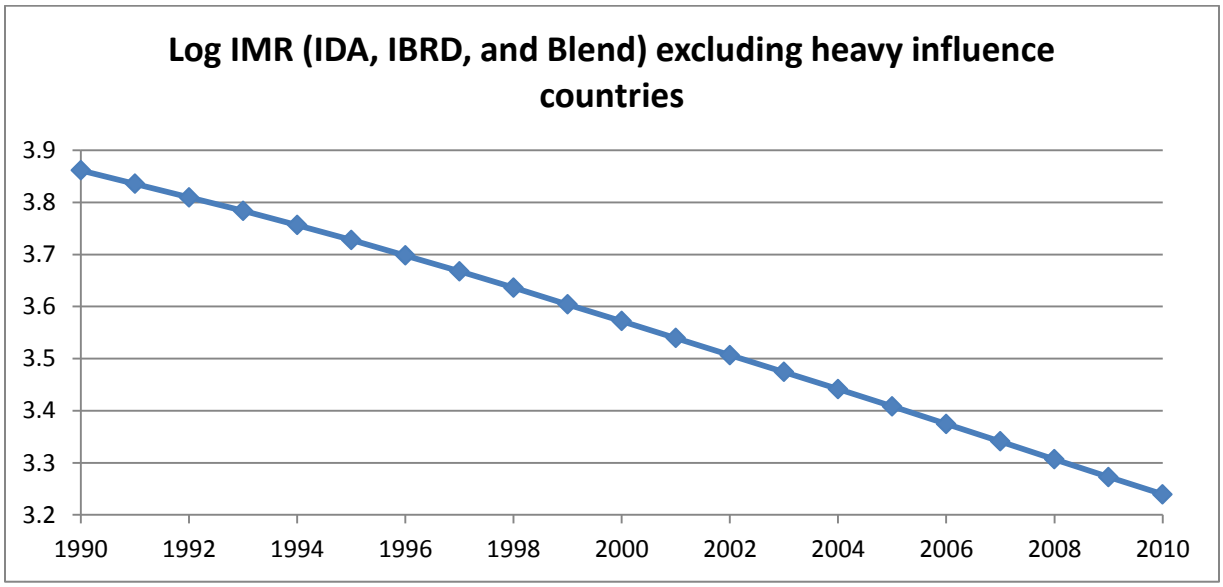
Heavy Influence Countries Identified:

IBRD, Blend, IDA: Latvia, Botswana, Namibia, Rwanda, South Africa, Swaziland

IDA Only: Lesotho, Rwanda, Haiti

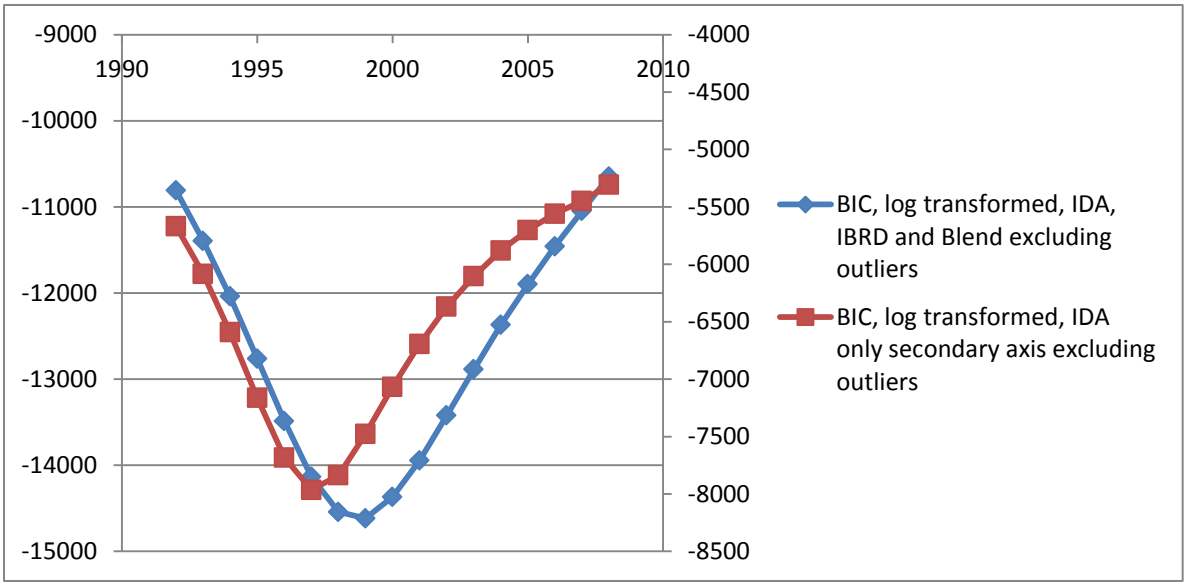
Transformed data (heavy influence countries removed):

After removing heavy influence countries, there is no obvious difference in the time series compared to the time series including the heavy influence countries.



BIC as a function of interrupted year: Log transformed removing heavy influence countries

The BIC curves excluding heavy influence countries is very similar to the curve including heavy influence countries for both the IDA, IBRD and Blend dataset and the IDA only dataset.



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

IDA, IBRD, Blend countries:

Year: 1999

β_2 (interrupted intercept): -0.00662 (p= 0.0079)

β_3 (interrupted slope): -0.00514 (p=0.0016)

IDA only countries:

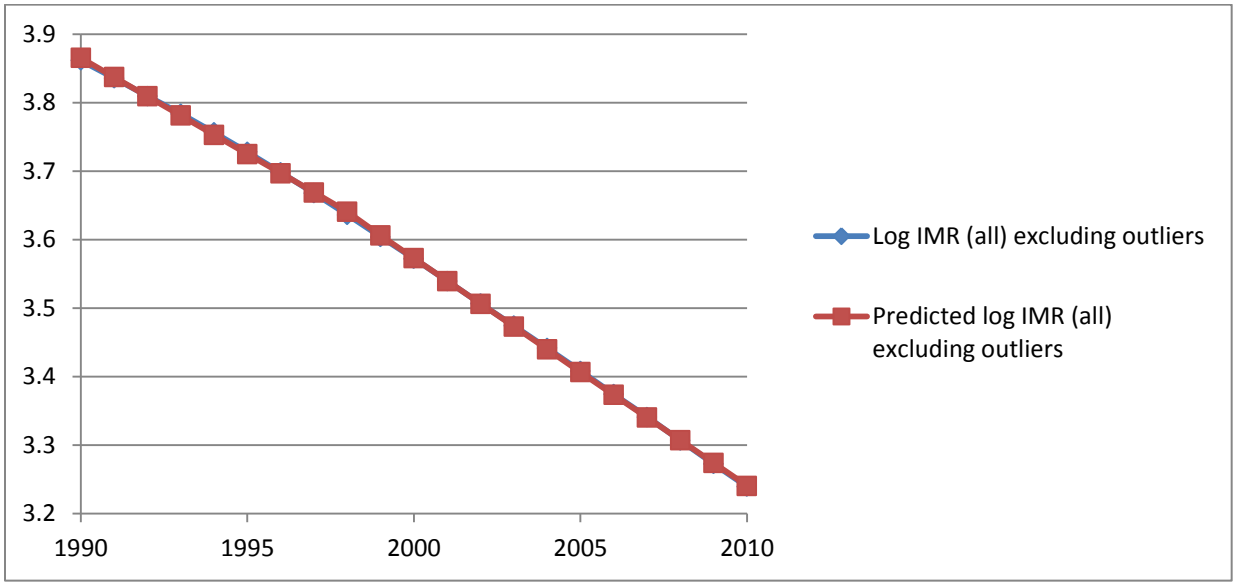
Year: 1997

β_2 (interrupted intercept): -0.00265 (p=0.1314)

β_3 (interrupted slope): -0.00719 (p=0.0003)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

Overall the data was extremely well fit by the model with the absolute percent deviation generally less than 0.1%.



Adding Non-Linear Fixed Effect:

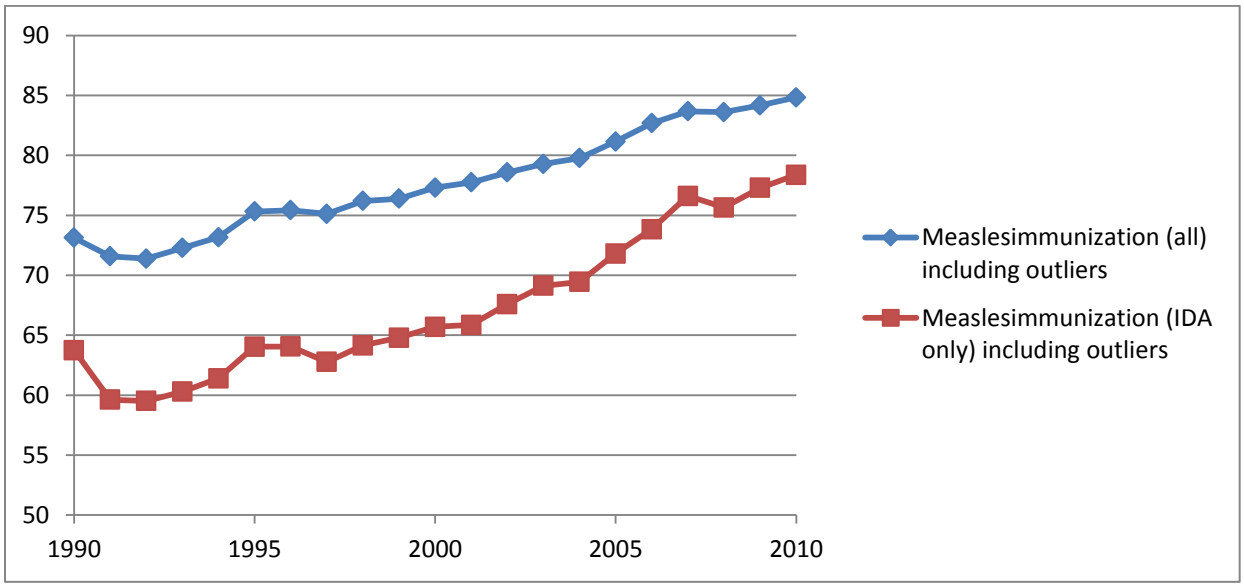
When the fixed effect of year^2 was added to the model for the datasets (excluding heavy influence countries) the interruption was no longer statistically significant.

Target 4A Indicator Proportion of 1 year-old children immunized against measles

Conclusion: There was no statistically significant acceleration or deceleration in the data set.

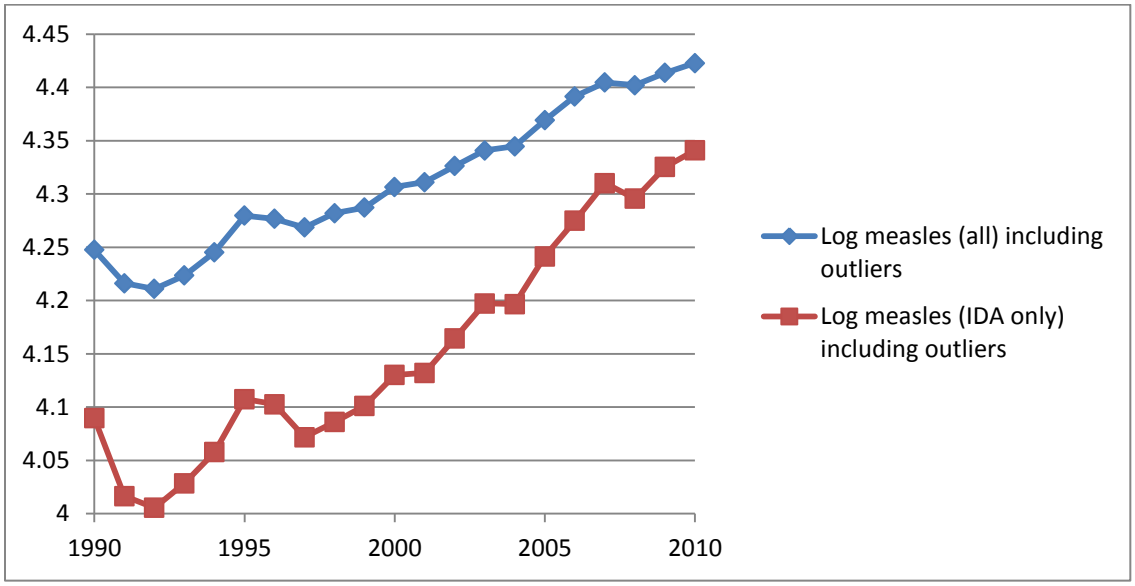
Non-transformed data:

The measles immunization rate declined for the first few years of the time period but then began rising around 1992. A second pattern of decline then acceleration occurred between 1995-1997 for both the IDA, IBRD and Blend dataset and the IDA only dataset.



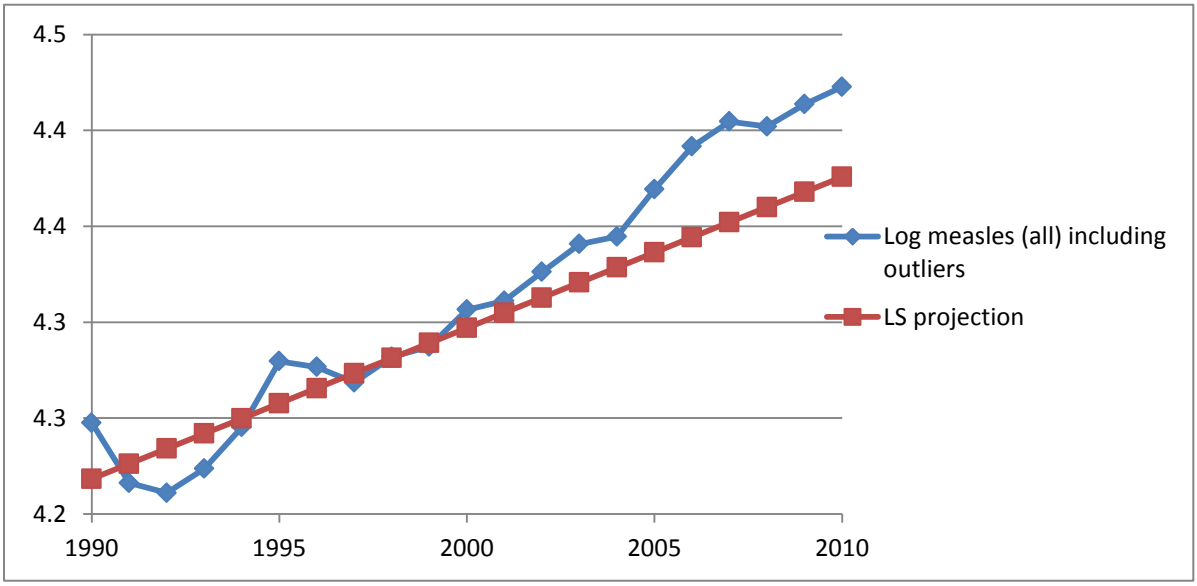
Transformed data:

The log measles immunization rate declined for the first few years of the time period but then began rising around 1992. A second pattern of decline then acceleration occurred between 1995-1997 for both the IDA, IBRD and Blend dataset and the IDA only dataset.

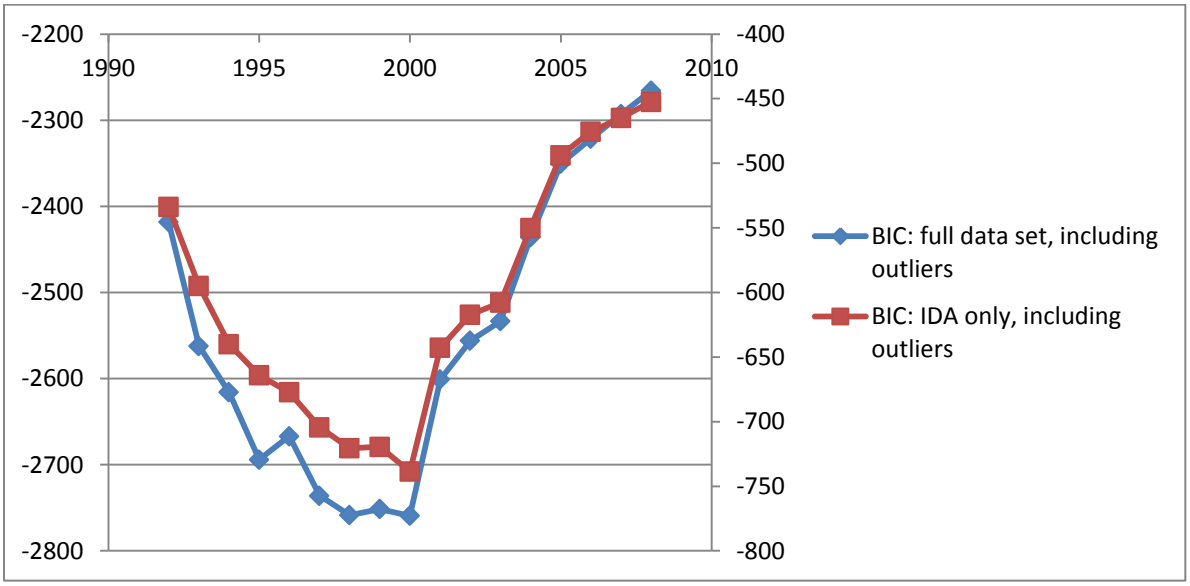


Transformed data: Comparison to time series and least squares regression

The linear regression mode shows clearly the variance between the trend in 1990-1999 and the overall dataset, further suggesting that an acceleration occurred during the time period.



BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.



The pattern of the BIC shows that there was a minimum in the IDA, IBRD and Blend dataset between 1998 to 2000 while the minimum for the IDA only dataset was more clearly in 2000. For the IDA, IBRD and Blend dataset the BIC curve also shows the local minimum around 1995 corresponding to the visual inspection.

Estimated coefficients from linear mixed model for optimal year.

IDA, IBRD, Blend countries:

Year: 2000

β_2 (interrupted intercept): 0.006273 (p= 0.7362)

β_3 (interrupted slope): 0.004793 (p=0.2361)

IDA only countries:

Year: 2000

β_2 (interrupted intercept: 0.016 (p=0.6656)

β_3 (interrupted slope): 0.01572 (p=0.0486)

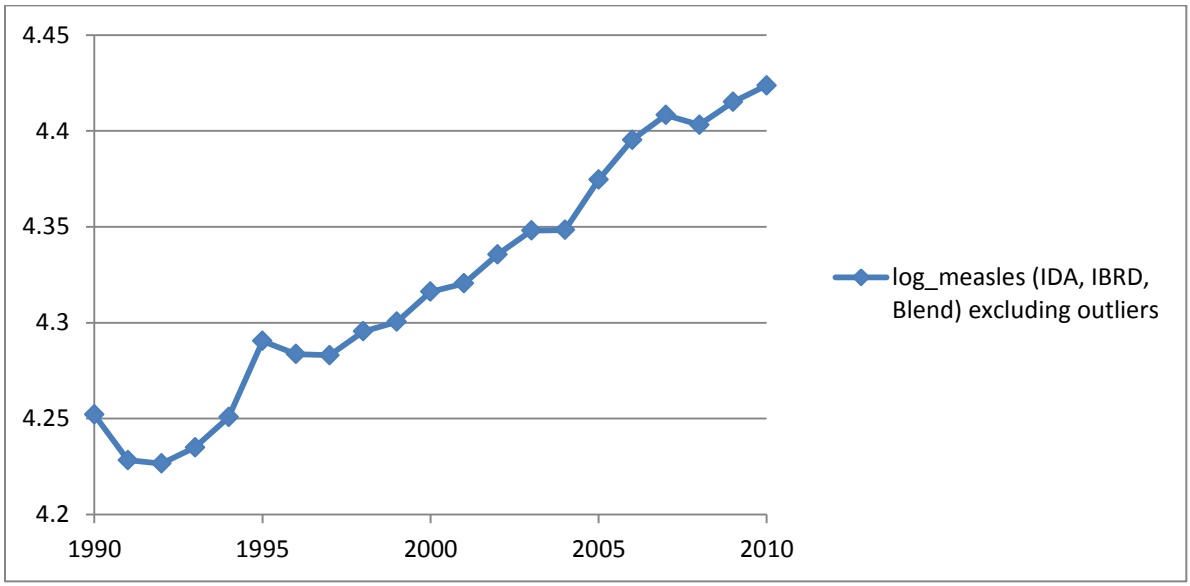
Heavy Influence Countries Identified:

IBRD, Blend, IDA: Congo, Rep., Ethiopia

IDA Only: None

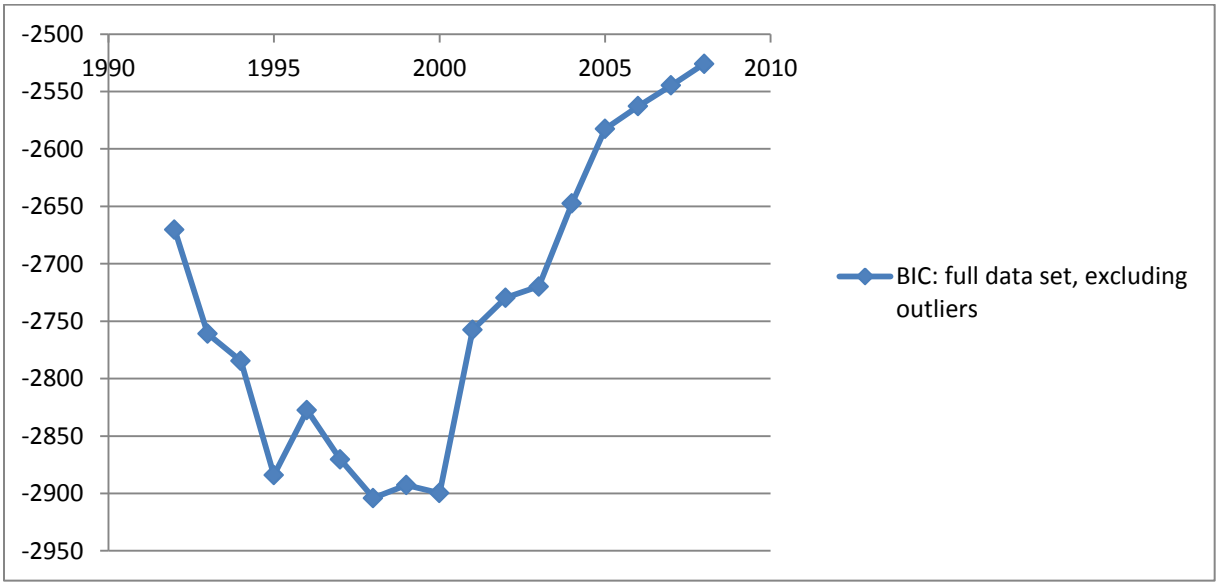
Transformed data (heavy influence countries removed):

After removing heavy influence countries, there is no obvious difference in the time series for the IDA, IBRD and Blend dataset compared to the time series including the heavy influence countries. Note that there were no heavy influence countries in the IDA only dataset.



BIC as a function of interrupted year: Log transformed removing heavy influence countries

The BIC curves excluding heavy influence countries is very similar to the curve including heavy influence countries for the IDA, IBRD and Blend dataset with a minimum around 1998-2000 but also a local minimum around 1995 corresponding to the local shift observed via visual inspection.



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

IDA, IBRD, Blend countries:

Year: 1998

β_2 (interrupted intercept): -0.00263 (p= 0.8782)

β_3 (interrupted slope): 0.003195 (p=0.4566)

IDA only countries: same as before since no heavy influence countries

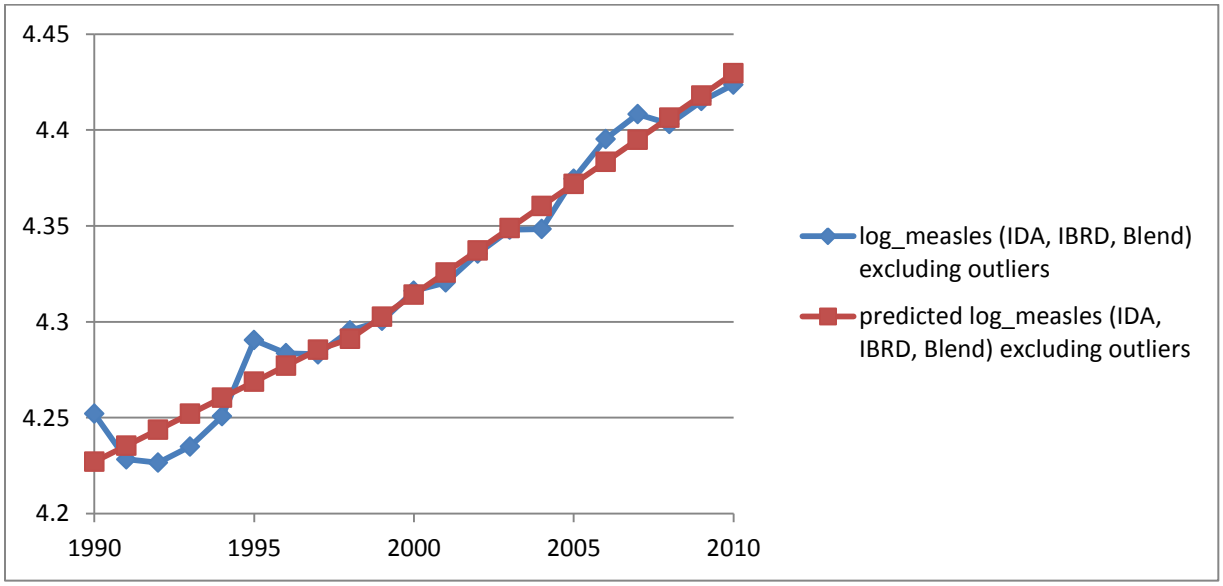
Year: 2000

β_2 (interrupted intercept: 0.016 (p=0.6656)

β_3 (interrupted slope): 0.01572 (p=0.0486)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

Overall the data was extremely well fit by the model with the absolute percent deviation generally less than 1%.



Adding Non-Linear Fixed Effect:

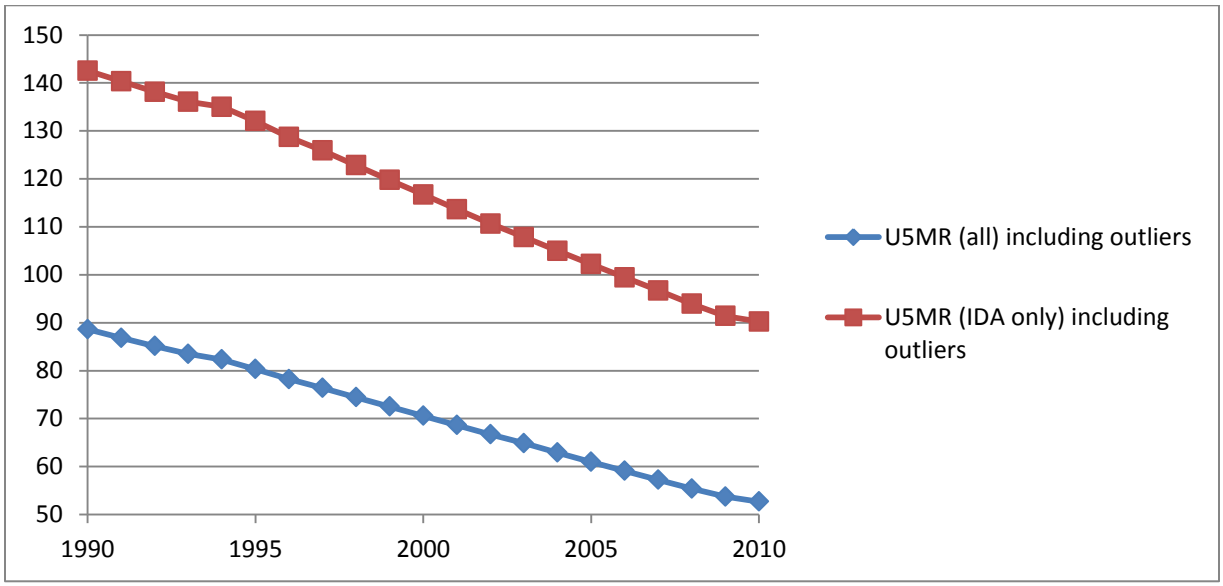
When the fixed effect of year^2 was added to the model for the datasets (excluding heavy influence countries) the results were unimpacted.

Target 4A Indicator Under-five mortality rate

Conclusion: There was an acceleration in the U5MR that occurred for both the IDA only and the IDA, IBRD and Blend dataset before 2000. The acceleration for the IDA only dataset occurred around 1997 while the acceleration for the IDA, IBRD and Blend dataset occurred around 1999.

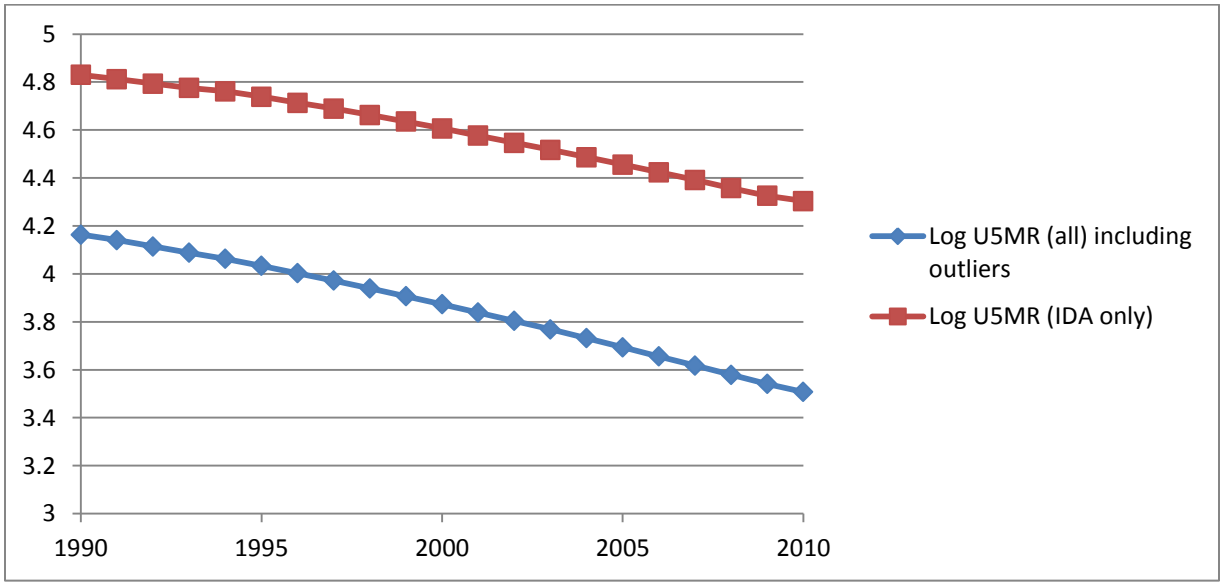
Non-transformed data:

The non-transformed data shows a fairly linear curve for both the IDA, IBRD and Blend dataset and the IDA only dataset with some suggestion of an acceleration around 2000.



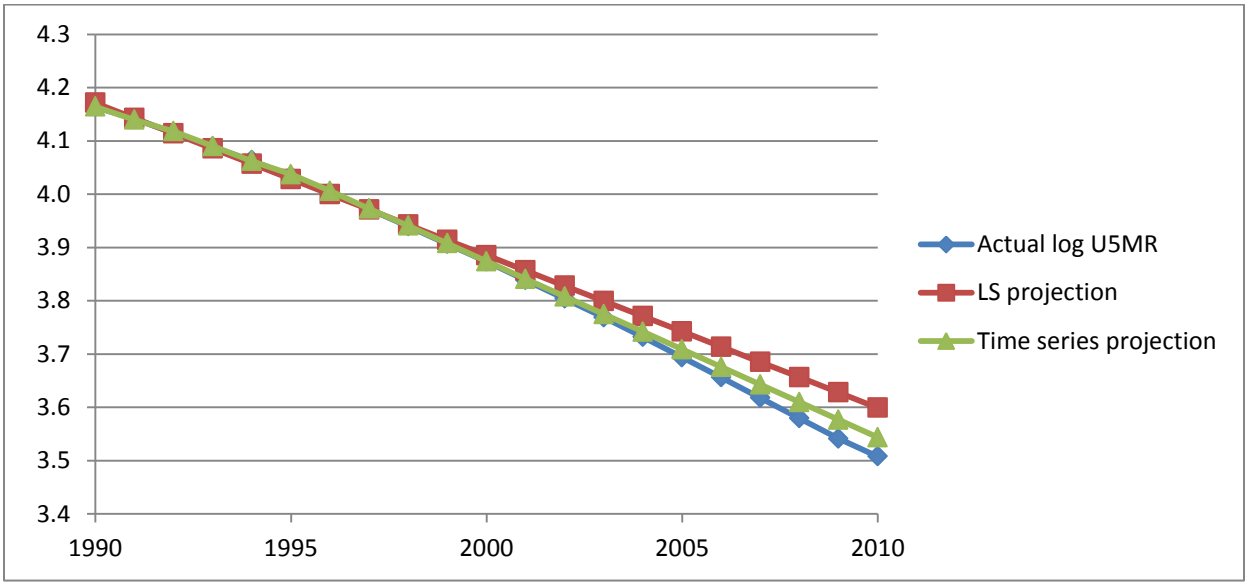
Transformed data:

The transformed data shows a fairly linear curve for both the IDA, IBRD and Blend dataset and the IDA only dataset with some suggestion of an acceleration around 2000.



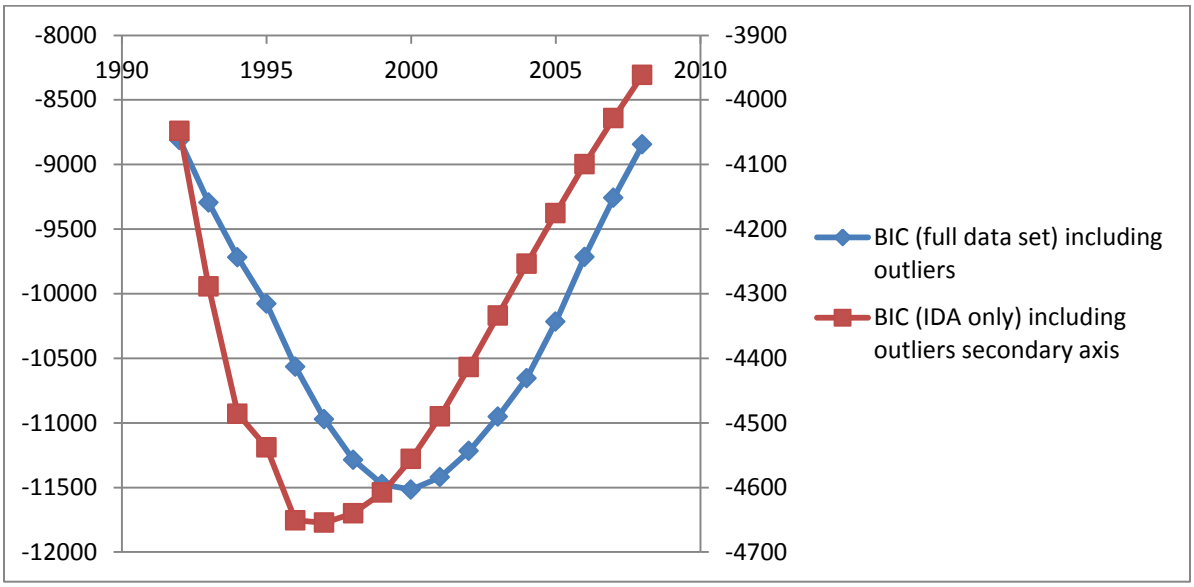
Transformed data: Comparison to time series and least squares regression

The comparison of the actual data to the least squares projection using 1990-1999 as input data suggests that there was an acceleration sometime before 2000 that was adequately captured by the time series projection.



BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.

The BIC curves show that the minimum for the IDA, IBRD and Blend dataset was around 2000 while the minimum for the IDA only was around 1997 suggesting that IDA countries had an earlier acceleration in the decline of the U5MR.



<u>Estimated coefficients from linear mixed model for optimal year.</u>

IDA, IBRD, Blend countries:

Year: 2000

β_2 (interrupted intercept): -0.0073 (p= 0.0515)

β_3 (interrupted slope): -0.00815 (p<0.0001)

IDA only countries:

Year: 1997

β_2 (interrupted intercept: -0.00362 (p= 0.5448)

β_3 (interrupted slope): -0.01133 (p=0.0003)

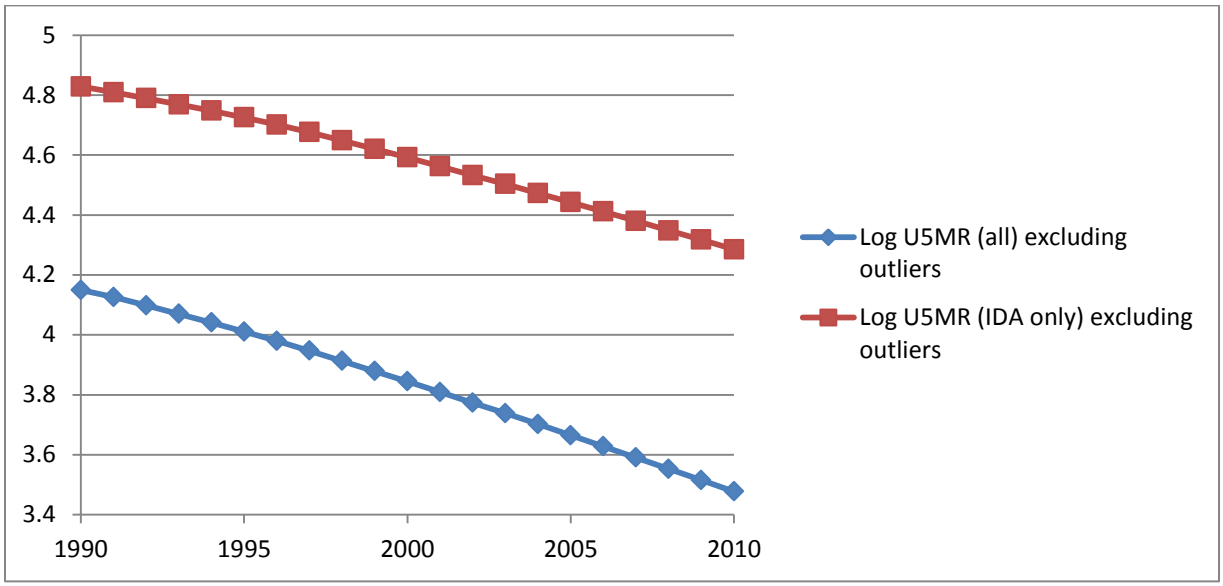
Heavy Influence Countries Identified:

IBRD, Blend, IDA: Haiti, Rwanda, Botswana, South Africa, Swaziland

IDA Only: Lesotho, Rwanda, Haiti

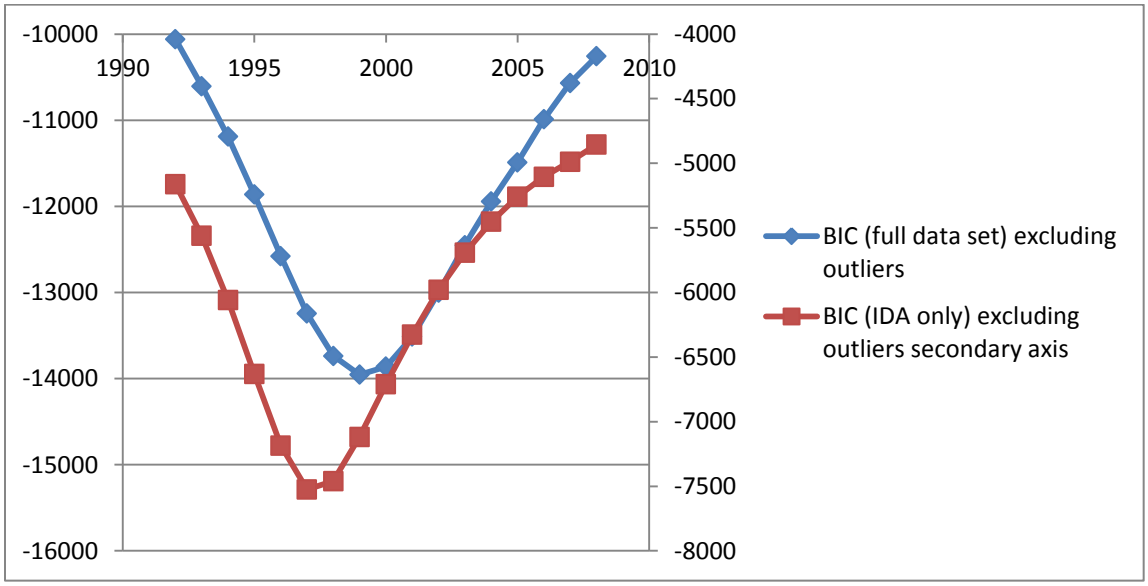
Transformed data (heavy influence countries removed):

After removing the heavy influence countries, the transformed curves don't appear substantially difference from the curve with the heavy influence countries included. The curves are still very linear (with a smoothness that raises some concerns about the input data being true measurements or model outputs themselves) with a suggestion of an acceleration around 2000.



BIC as a function of interrupted year: Log transformed removing heavy influence countries

The BIC curves with the heavy influence countries removed display a similar shape as the curve with the heavy influence countries included. The IDA, IBRD, Blend dataset has a minimum around 1999 while the IDA only dataset has a minimum around 1997 indicating that the IDA only countries has an earlier acceleration.



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

IDA, IBRD, Blend countries:

Year: 1999

β_2 (interrupted intercept): -0.00595 (p= 0.0458)

β_3 (interrupted slope): -0.00657 (p=0.0002)

IDA only countries: same as before since no heavy influence countries

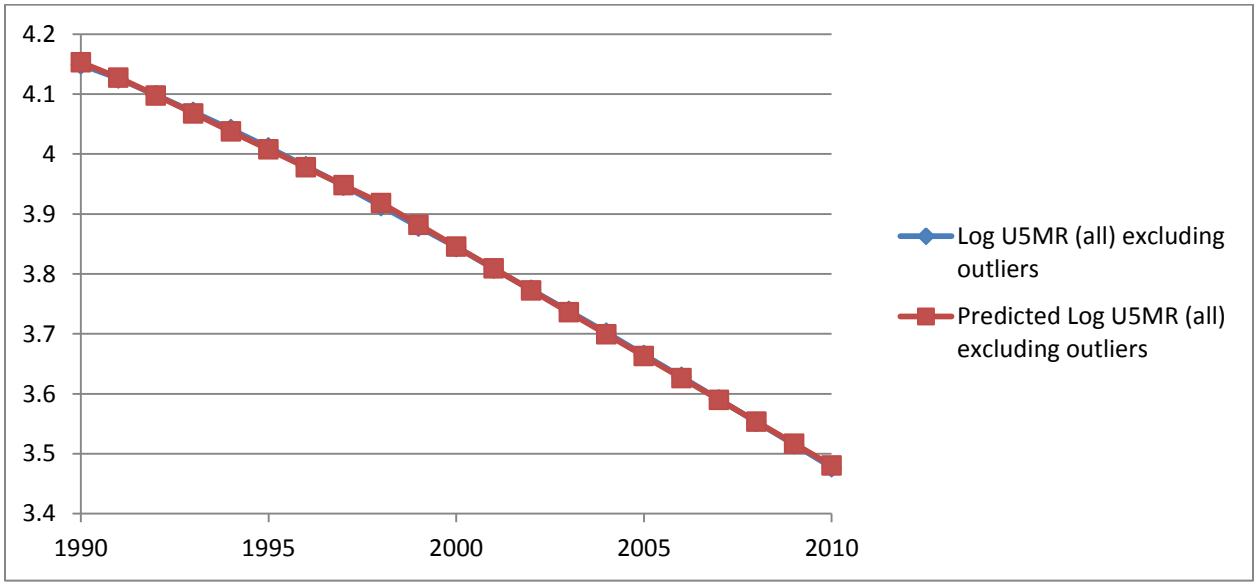
Year: 1997

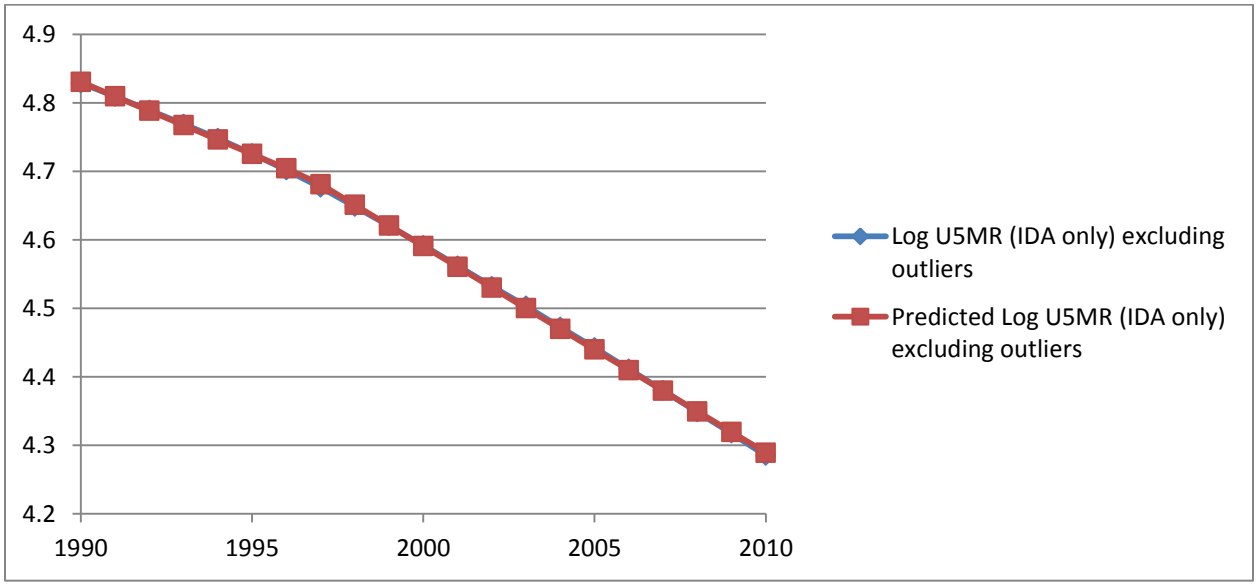
β_2 (interrupted intercept: -0.00201(p= 0.2974)

β_3 (interrupted slope): -0.00909 (p=0.0001)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

Overall the data was extremely well fit by the model with the absolute percent deviation generally less than 0.1%





Adding Non-Linear Fixed Effect:

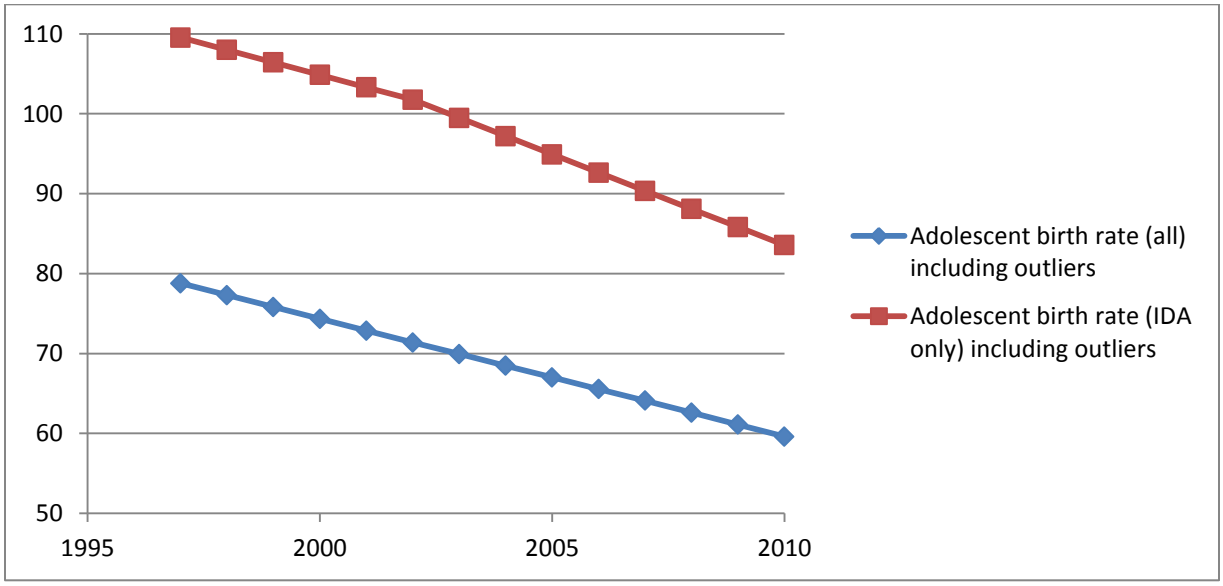
When the fixed effect of year^2 was added to the model for the datasets (excluding heavy influence countries) the interruption in the slope and intercept now had p-values of p=0.02 in the IDA only model; for the IDA, IBRD and Blend dataset, the adding of a year^2 term into the model results in the interrupted slope and intercept no longer being significant.

Target 5B Indicator Adolescent birth rate

Conclusion: This dataset was limited to 1997 to 2010. The IDA only dataset did not have a significant changepoint but the IDA, IBRD, and Blend dataset had a deceleration in the improvement of the adolescent birth rate starting in 2004.

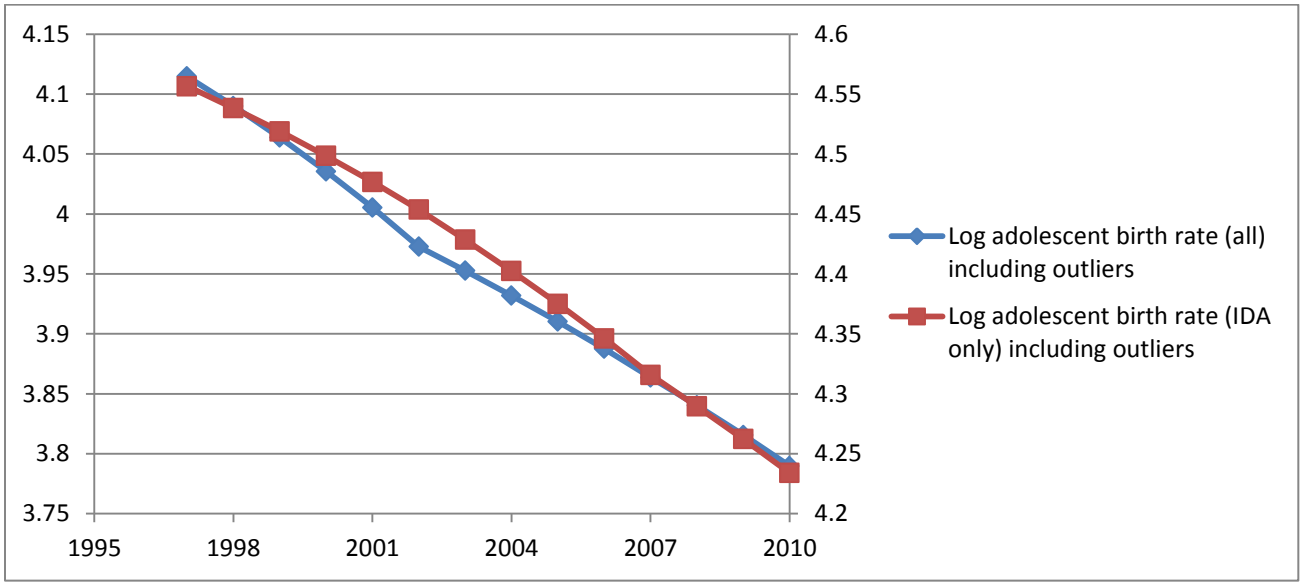
Non-transformed data:

The non-transformed data shows a fairly linear curve for both the IDA, IBRD and Blend dataset and the IDA only dataset with some suggestion of an acceleration around 2003 for the IDA, IBRD and Blend dataset.



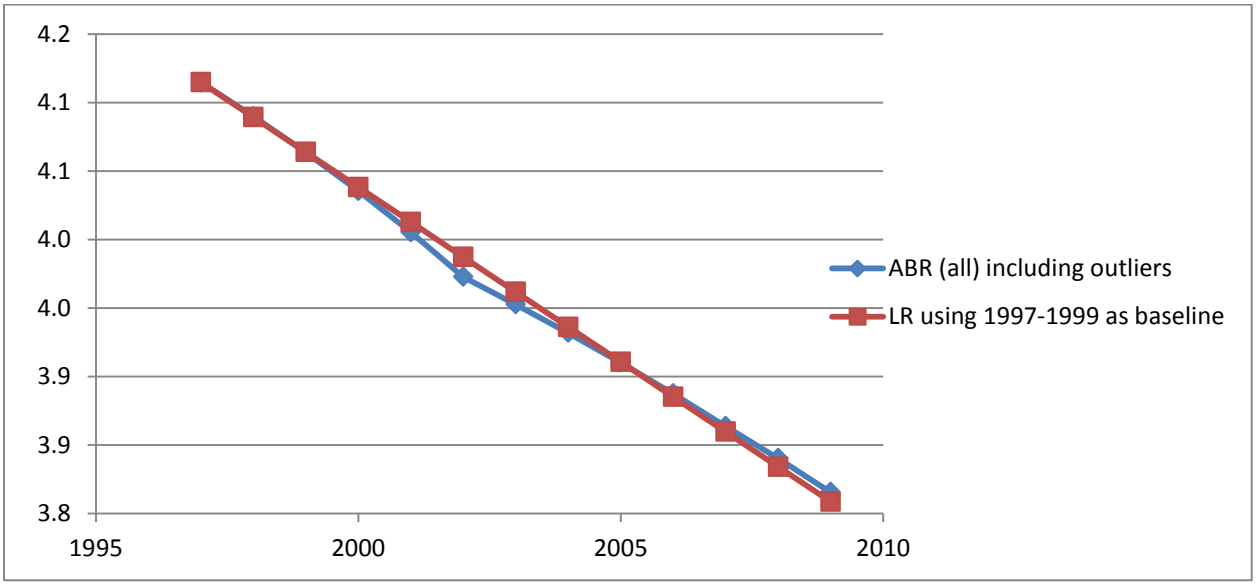
Transformed data:

The transformed data shows a fairly linear curve for both the IDA, IBRD and Blend dataset and the IDA only dataset with no clear indications of an acceleration in the decline of the adolescent birth rate.



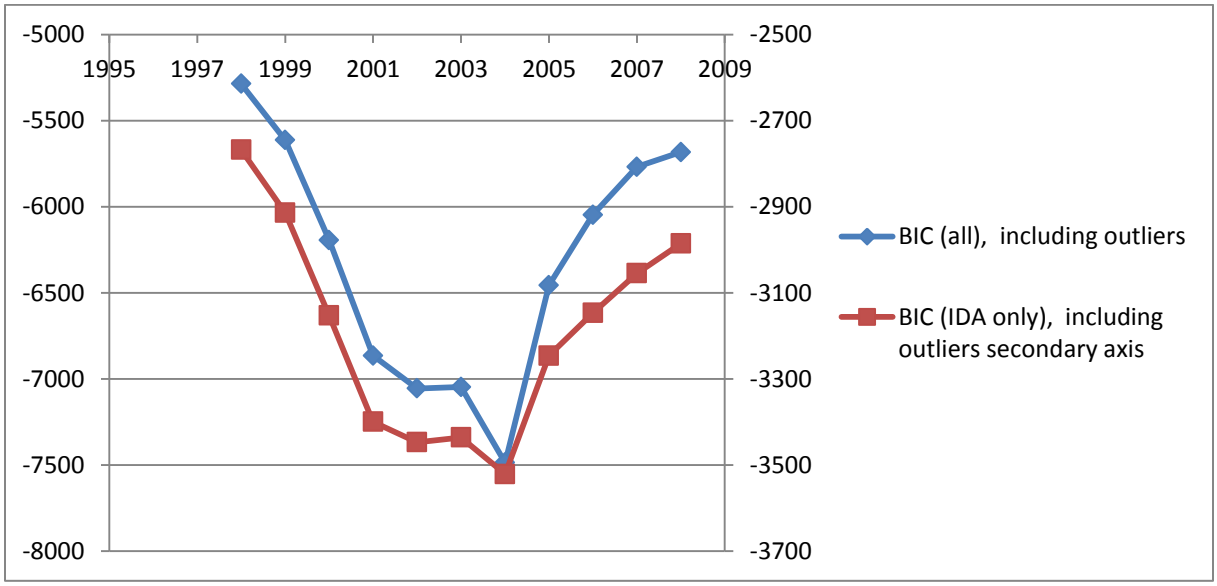
Transformed data: Comparison to least squares regression

The comparison of the actual data to the least squares projection using 1997-1999 as input data does not demonstrate an acceleration. Time series analysis for the baseline period was not possible due to the limited number of data points.



BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.

The BIC curves show that the minimum for the IDA, IBRD and Blend dataset and the IDA only dataset was around 2004. The asymmetric pattern around the minimum BIC was generally not seen in most other BIC curves suggesting the impact of a few heavy influence countries.



<u>Estimated coefficients from linear mixed model for optimal year.</u>

IDA, IBRD, Blend countries:

Year: 2004

β_2 (interrupted intercept): 0.03923 (p <.0001)

β_3 (interrupted slope): 0.004131 (p=0.1431)

IDA only countries:

Year: 2004

β_2 (interrupted intercept: 0.0127 (p =0.0726)

β_3 (interrupted slope): -0.00684 (p=0.0193)

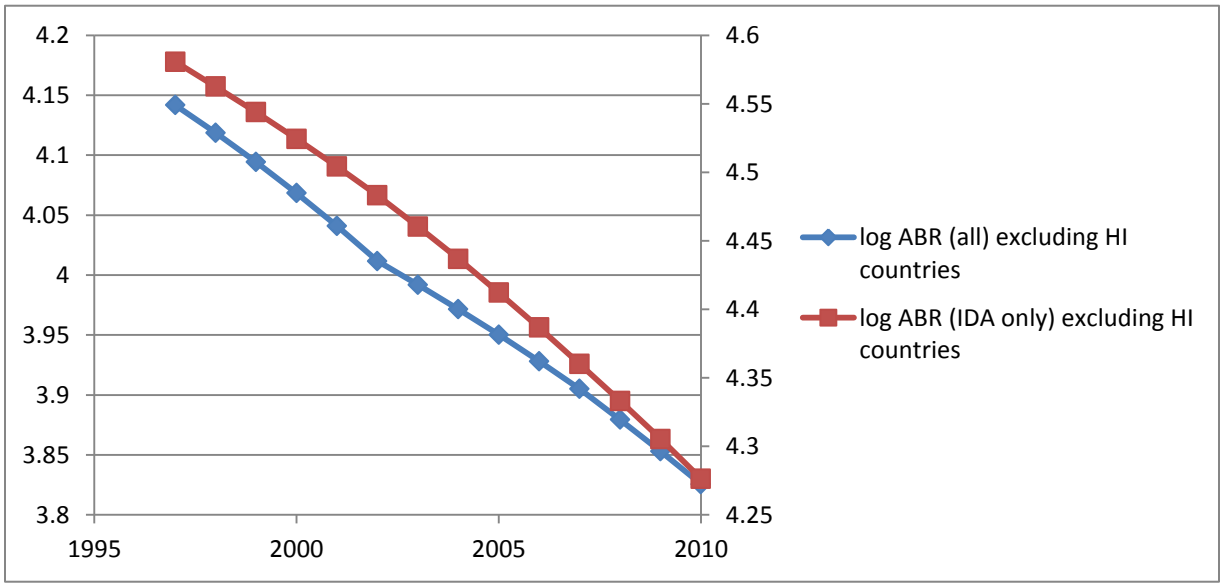
Heavy Influence Countries Identified:

IBRD, Blend, IDA: Korea, Rep, Maldives, Uzbekistan

IDA Only: Burundi, Maldives, Mozambique

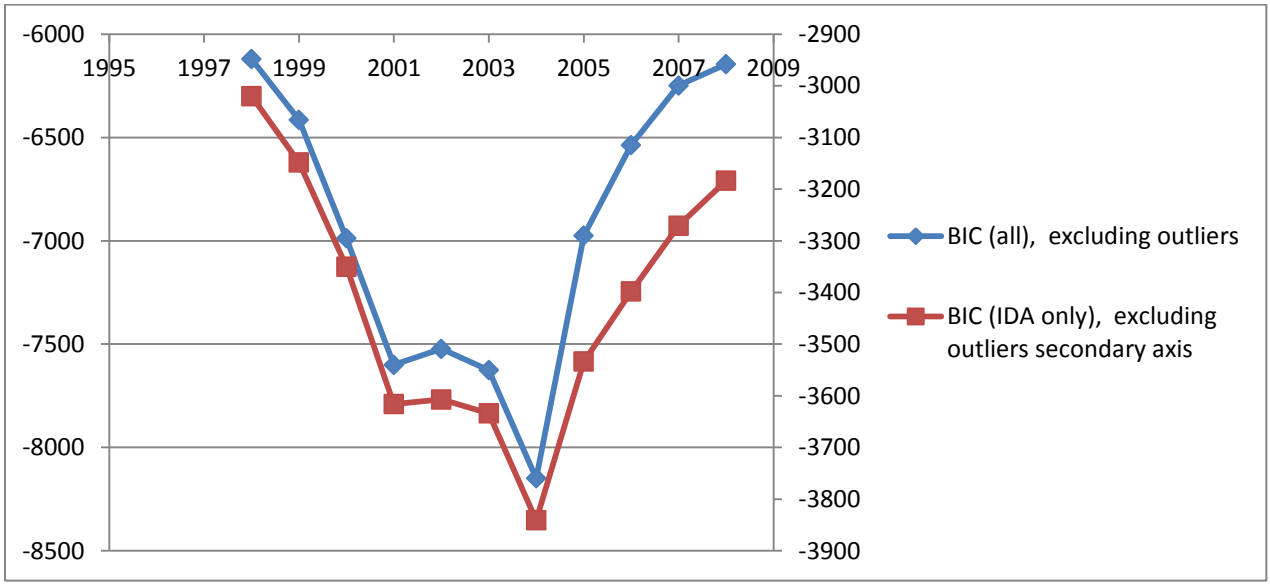
Transformed data (heavy influence countries removed):

After removing the heavy influence countries, the transformed curves don't appear substantially different from the curve with the heavy influence countries included. The curves are still very with a suggestion of an acceleration in the IDA only curve and a suggestion of a deceleration in the IDA, IBRD and Blend curve



BIC as a function of interrupted year: Log transformed removing heavy influence countries

The BIC curves with the heavy influence countries removed display a similar shape as the curves that included the heavy influence countries yet the minimum is more pronounced in these curves, clearly appearing at 2004 for both datasets.



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

The regression results excluding heavy influence countries is similar to that which included the heavy influence countries with the IDA only dataset now displaying regression coefficients that are close to statistical significance but offsetting direction making the interpretation difficult.

IDA, IBRD, Blend countries:

Year: 2004

β_2 (interrupted intercept): 0.03592 (p <.0001)

β_3 (interrupted slope): 0.001277 (p=0.5644)

IDA only countries: same as before since no heavy influence countries

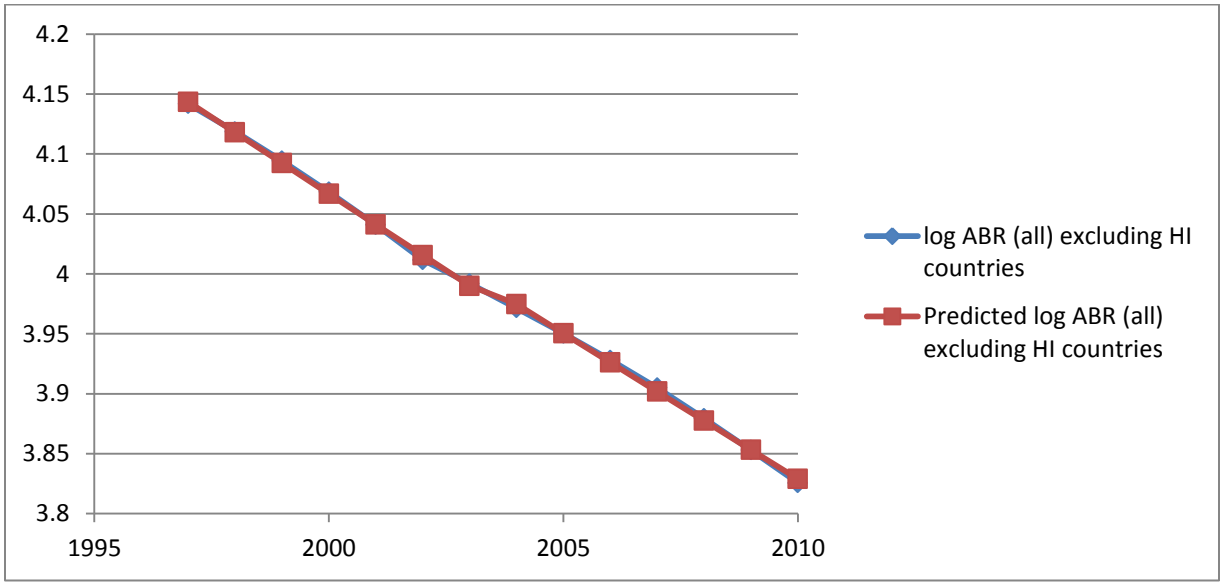
Year: 2004

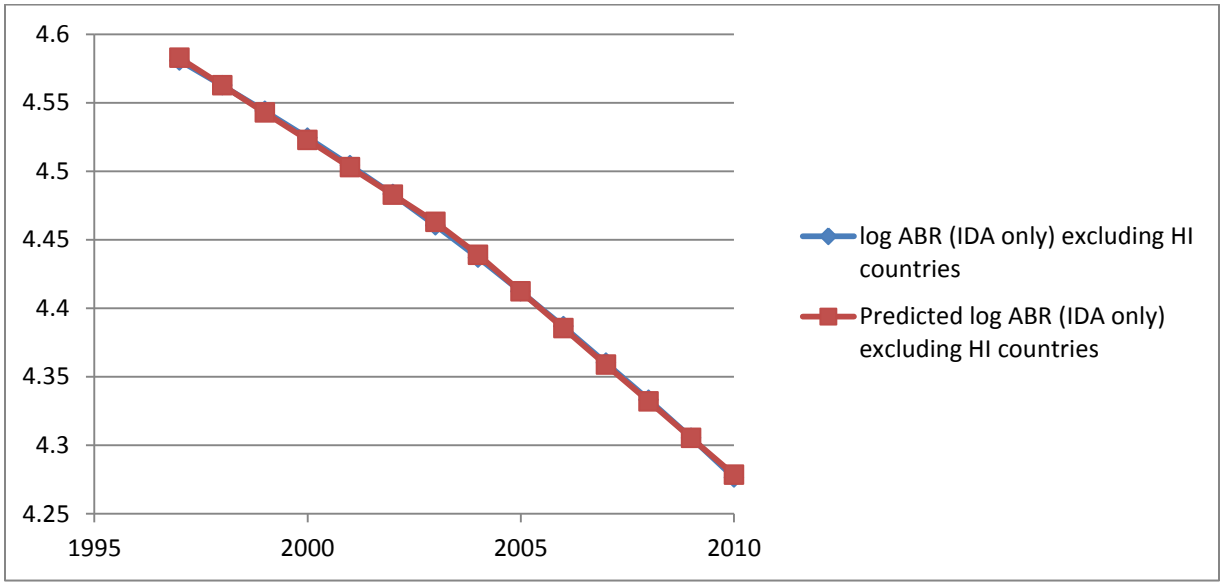
β_2 (interrupted intercept: 0.01597 (p=0.0052)

β_3 (interrupted slope): -0.00676 (p=0.003)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

Overall the data was extremely well fit by the model with the absolute percent deviation generally less than 0.1%





Adding Non-Linear Fixed Effect:

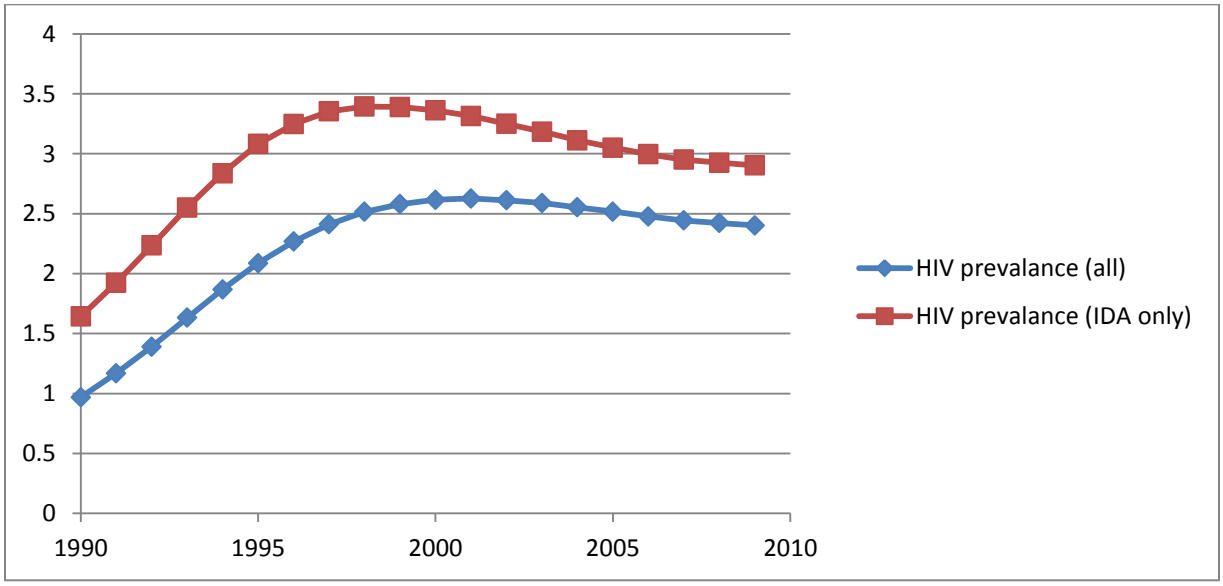
When the fixed effect of year^2 was added to the model for the IDA, IBRD and Blend dataset, the conclusions were unchanged. For the IDA only dataset (excluding heavy influence countries) the interrupted intercept was now positive and statistically significant (previously it was positive and nearly statistically significant).

Target 6A Indicator HIV prevalence among population aged 15-24 years

Conclusion: There was a clear changepoint in the HIV prevalence starting around 1996-1997 for both the IDA only and the IDA, IBRD and Blend countries where the prevalence peaked and then began to fall after that time period.

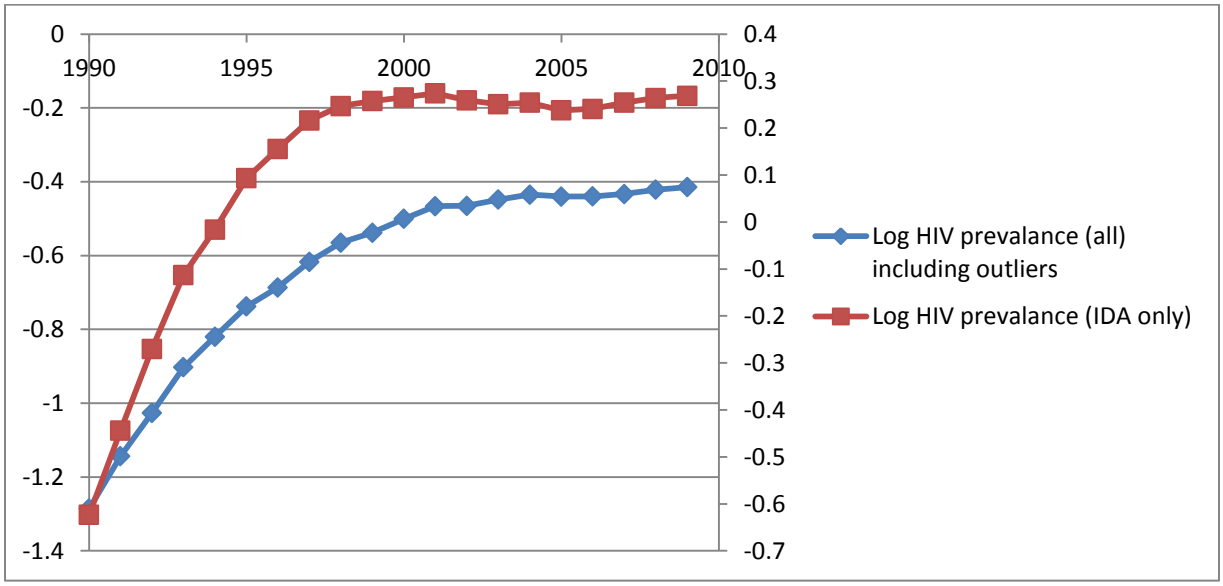
Non-transformed data:

The non-transformed data shows a clear changepoint in the HIV prevalence for both curves, with the increasing trend peaking then beginning to decline starting around 1997 for the IDA only data and slightly later (around 1998) for the IDA, IBRD and Blend dataset.



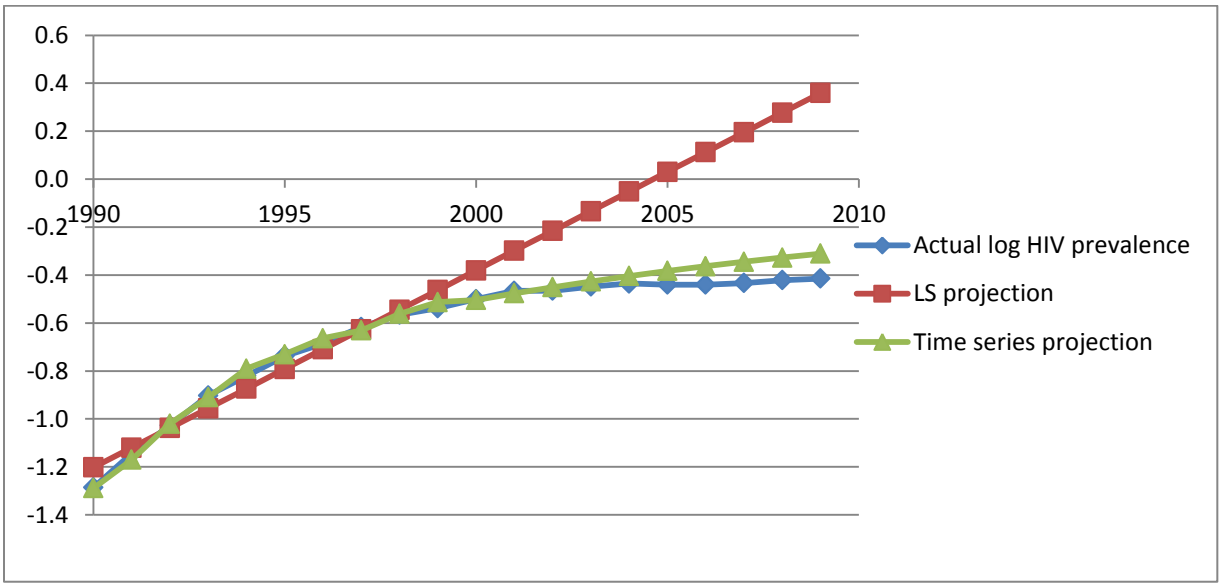
Transformed data:

The transformed data shows a clear changepoint in the HIV prevalence for both curves, with the increasing trend peaking then beginning to decline starting around 1997 for the IDA only data and slightly later (around 1998) for the IDA, IBRD and Blend dataset.



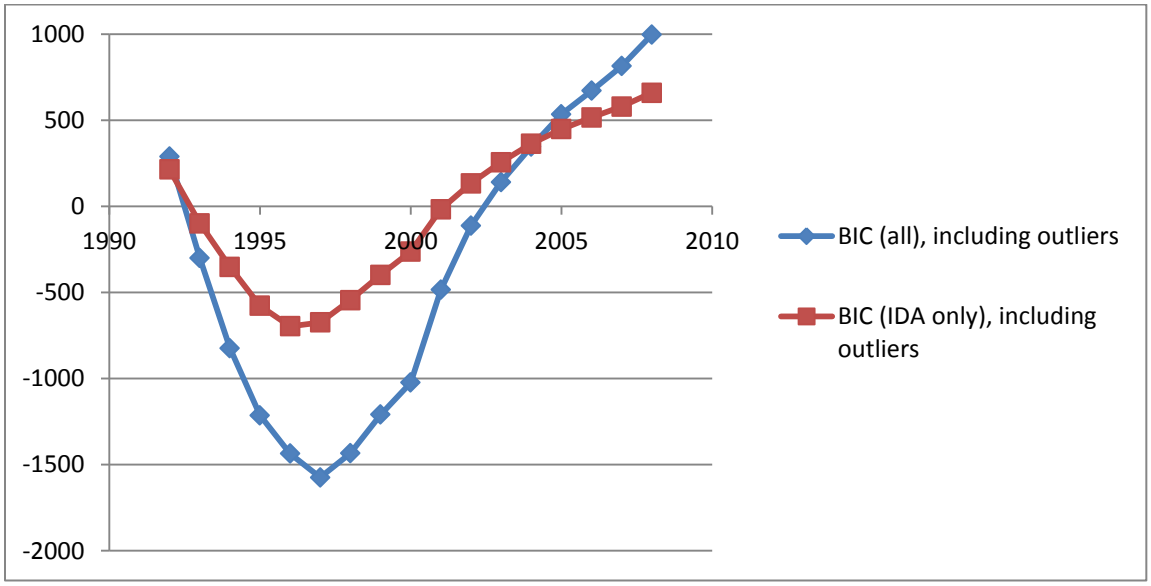
Transformed data: Comparison to least squares regression

The comparison of the actual data to the least squares and the time series projection displays clearly that there was a deviation from the linear trend starting in the late 1990's. The time series analysis projection (using 1990-1999 as baseline data) matches well with the actual data, suggesting that the mechanism for acceleration occurred before 2000.



BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.

The BIC curves including the heavy influence countries show a clear minimum for both curves around 1997 with the IDA only curve having a minimum that is slightly earlier (1996).



Estimated coefficients from linear mixed model for optimal year.

IDA, IBRD, Blend countries:

Year: 1997

β_2 (interrupted intercept): -0.0443 (p= 0.0840)

β_3 (interrupted slope): -0.09339 (p<0.0001)

IDA only countries:

Year: 1996

β_2 (interrupted intercept: -0.04821 (p= 0.2015)

β_3 (interrupted slope): -0.145 (p<0.0001)

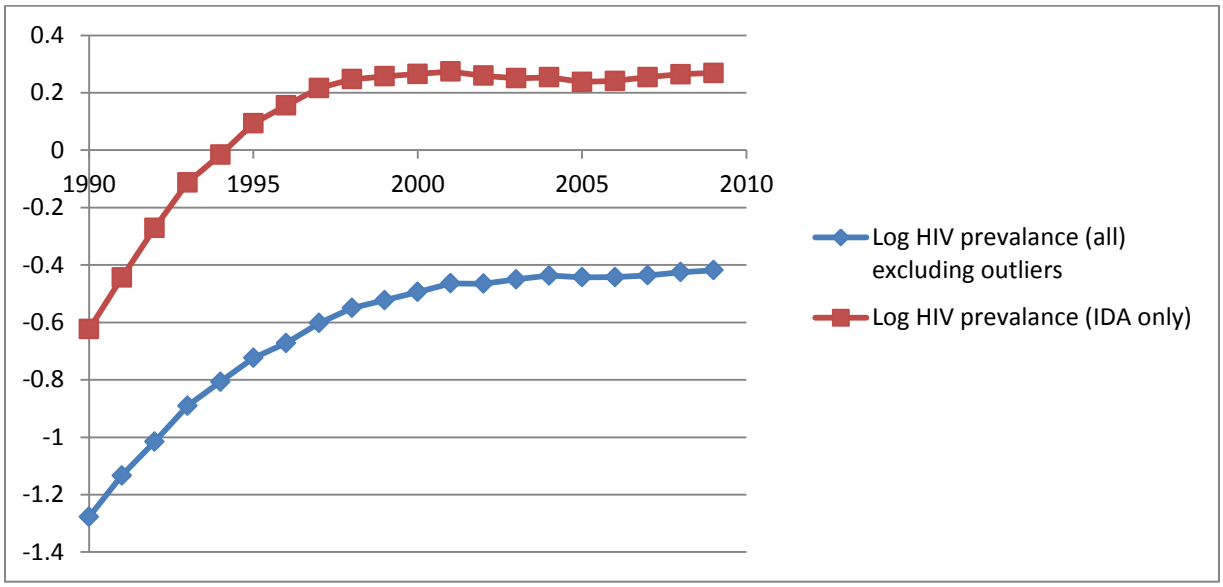
Heavy Influence Countries Identified:

IDA, IBRD, Blend: Russian Federation

IDA Only: None

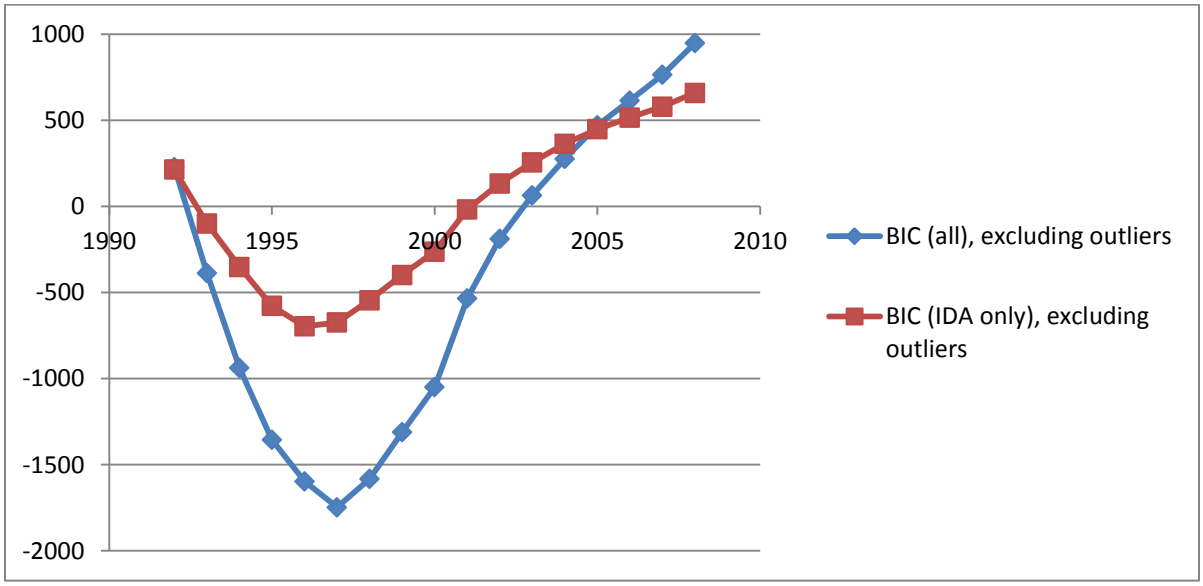
Transformed data (heavy influence countries removed):

After removing the heavy influence countries, the transformed curves are virtually identical to the previous curves due to the fact that there was only one heavy influence in the IDA, IBRD, Blend group and no heavy influence countries in the IDA only group.



BIC as a function of interrupted year: Log transformed removing heavy influence countries

The BIC curves excluding the heavy influence countries are nearly identical to the curves including the heavy influence countries (Note that there were no heavy influence countries for the IDA only curve and only one heavy influence country for the IDA, IBRD and Blend countries.). There is a clear minimum for both curves around 1997 with the IDA only curve having a minimum that is slightly earlier (1996).



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

The regression results excluding heavy influence countries is similar to that which included the heavy influence countries with the IDA only dataset now displaying regression coefficients that are close to statistical significance but offsetting direction making the interpretation difficult.

IDA, IBRD, Blend countries:

Year: 1997

β_2 (interrupted intercept): -0.04509 (p= 0.0813)

β_3 (interrupted slope): -0.09566 (p<0.0001)

IDA only countries: same as before since no heavy influence countries

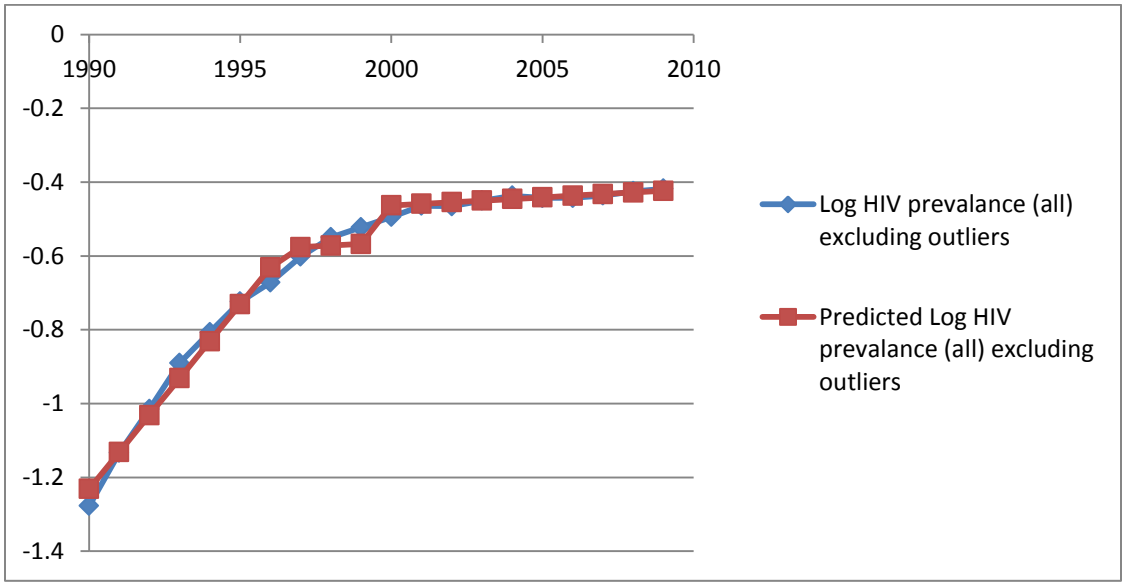
Year: 1996

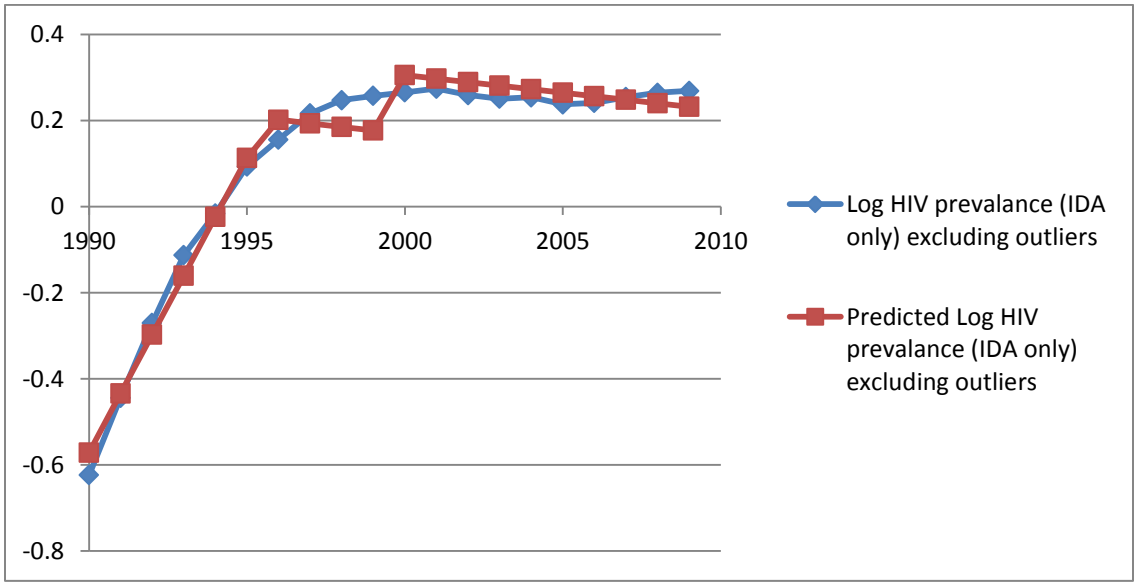
β_2 (interrupted intercept: -0.04821 (p= 0.2015)

β_3 (interrupted slope): -0.145 (p<0.0001)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

Overall the data was extremely well fit by the model. The absolute percent deviation was sometimes greater than 5% but this was mostly due to the fact that the values were close to zero so measures of absolute percent variance were amplified.





Adding Non-Linear Fixed Effect:

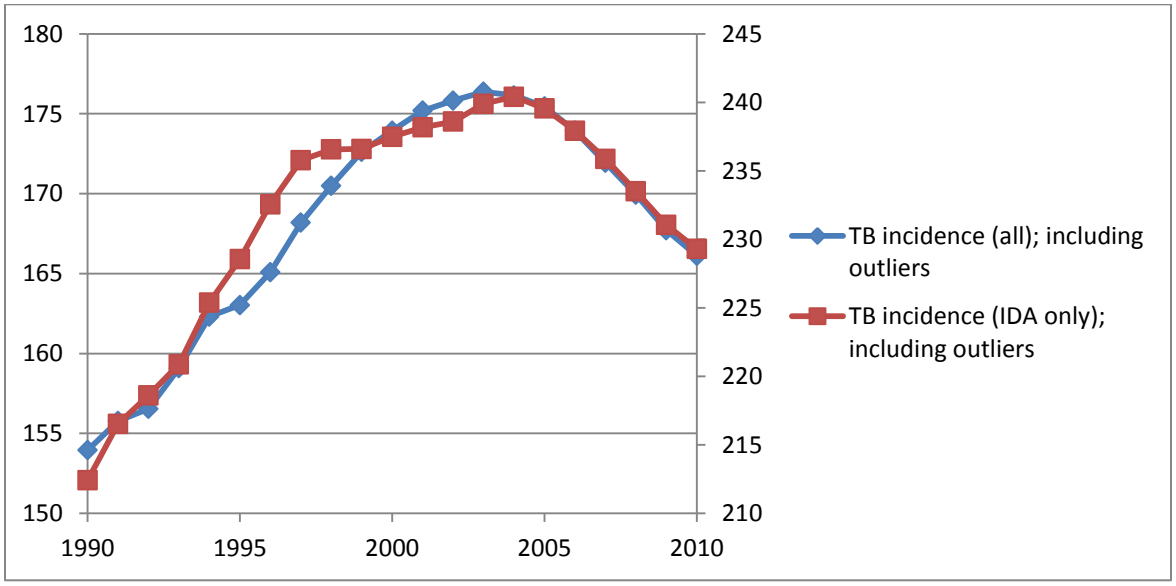
When the fixed effect of year^2 was added to the model for the IDA, IBRD and Blend dataset as well as the IDA only dataset, the conclusions were unchanged. For both datasets there was still a statistically significant deceleration in the HIV prevalence (1996 for the IDA only; 1997 for the IDA, IBRD, and Blend dataset)

Target 6C Indicator Incidence of tuberculosis (per 100,000 people)

Conclusion: The tuberculosis incidence rate began declining sharply for the IDA, IBRD and Blend countries in 2000 while the changepoint for the IDA only countries was 2001 (excluding heavy influence countries) and 1999 (including heavy influence countries).

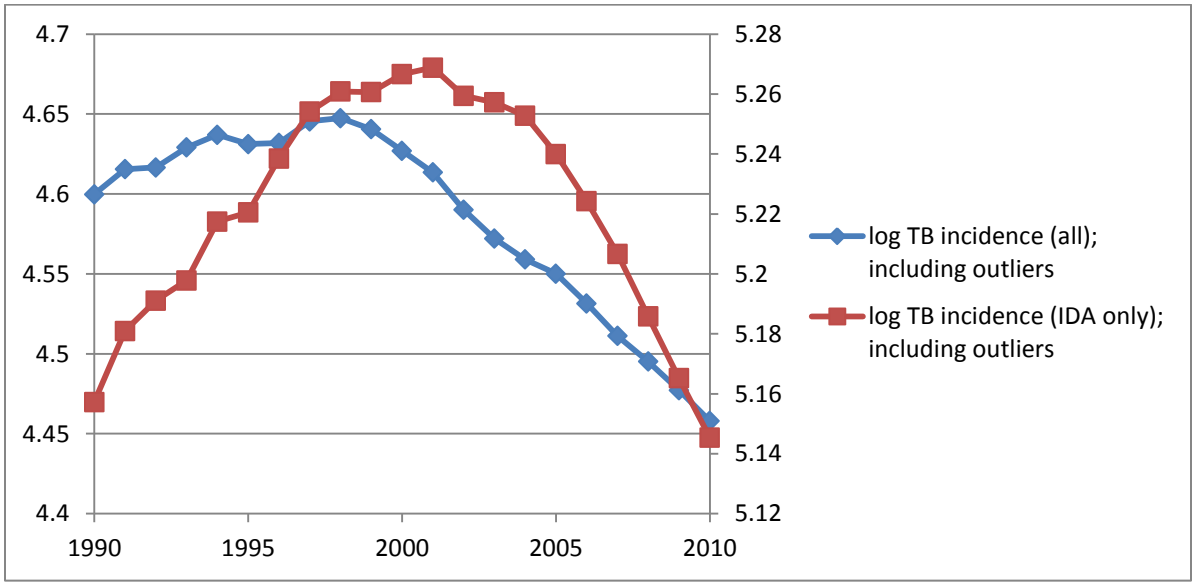
Non-transformed data:

The non-transformed data shows a clear changepoint in the TB incidence around 2002 for the IDA, IBRD and Blend dataset. The curve for the IDA only dataset is more complicated with what appears to be two difference changepoints, one around 1996 and another around 2003.



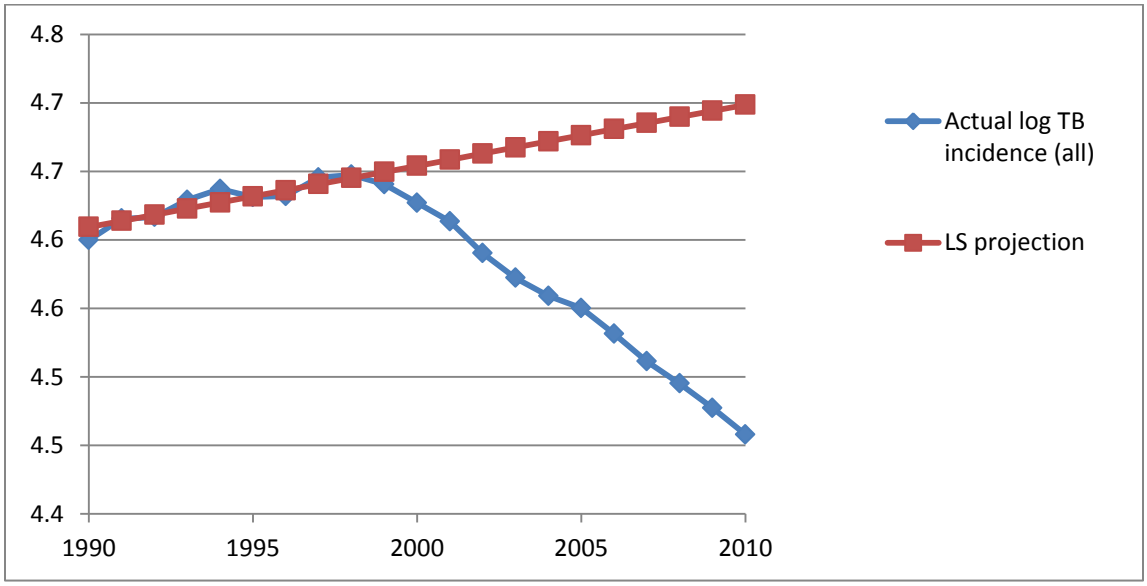
Transformed data:

The transformed data shows a clearer trend than the non-transformed data. Here we observe a clear changepoint for the TB incidence around 1998 for the IDA, IBRD and Blend dataset. The curve for the IDA only dataset is more complicated with what appears to be two difference changepoints, one around 1996 when the incidence began leveling off and another around 2004 when the incidence began to sharply decline versus the slower decline exhibited from 2001 to 2004.



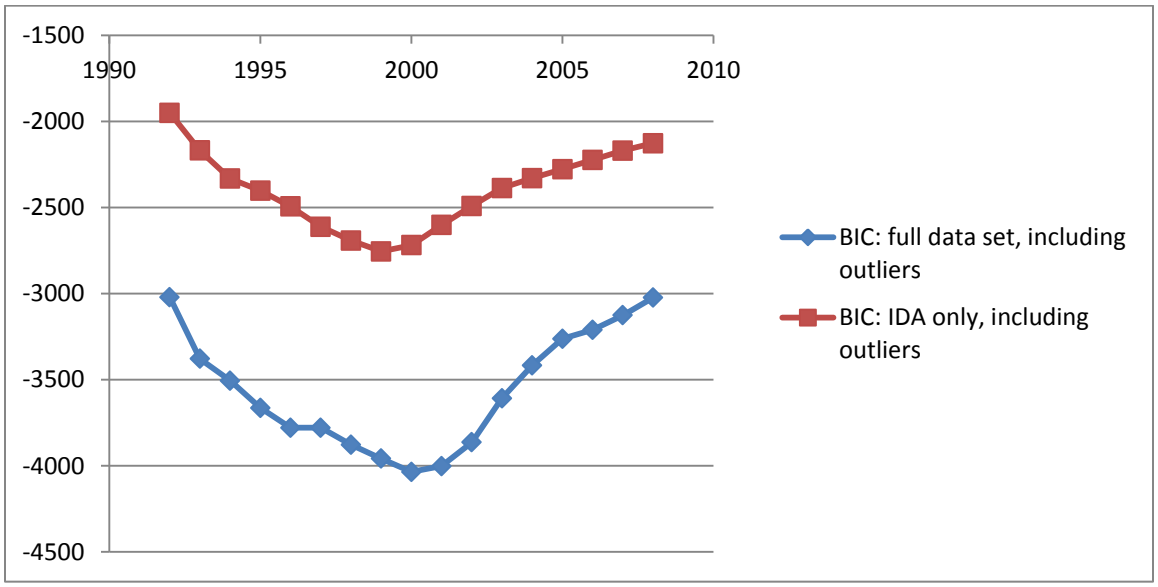
Transformed data: Comparison to least squares regression

The comparison of the actual data to the least squares and the time series projection displays clearly that there was a deviation from the linear trend starting around 2000 for the IDA, IBRD and Blend dataset.



BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.

The BIC curves including the heavy influence countries show a clear minimum for both curves around 2000 with the IDA only curve having a minimum that is slightly earlier (1999).



Estimated coefficients from linear mixed model for optimal year.

IDA, IBRD, Blend countries:

Year: 2000

β_2 (interrupted intercept): -0.02693 (p= 0.0998)

β_3 (interrupted slope): -0.02105 (p<0.0001)

IDA only countries:

Year: 1999

β_2 (interrupted intercept: 0.01226 (p=0.5376)

β_3 (interrupted slope): -0.02349 (p<0.0001)

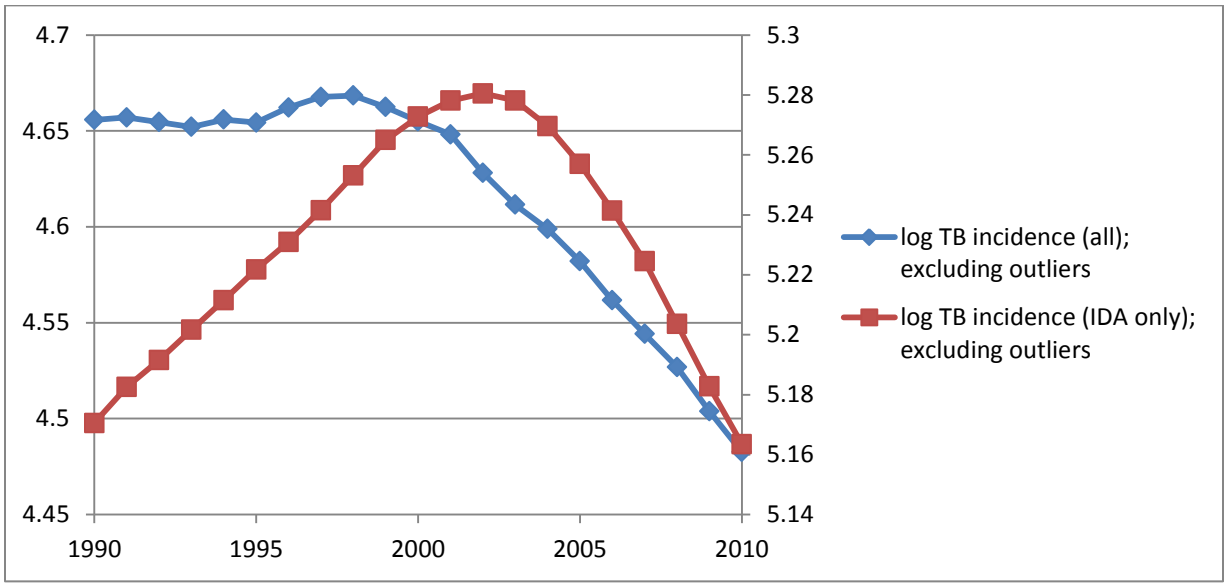
Heavy Influence Countries Identified:

IDA, IBRD, Blend: Antigua and Barbuda, Kiribati, Palau, St. Kitts and Nevis

IDA Only: Kiribati, Mali, Vanuatu

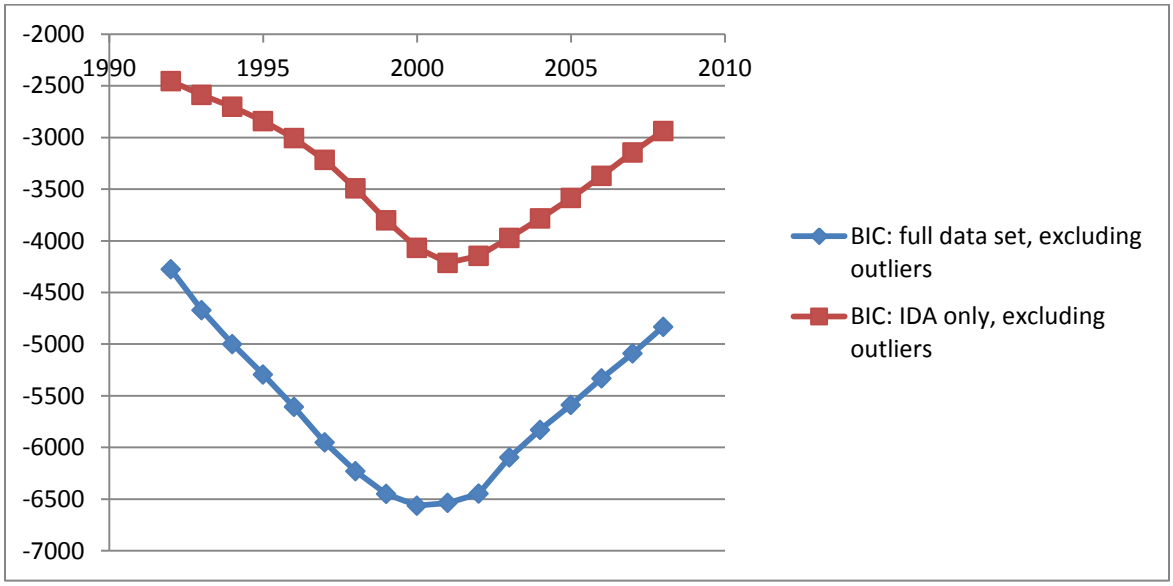
Transformed data (heavy influence countries removed):

After removing the heavy influence countries, the transformed curves are similar to the previous curves but with clearer trends. One can easily see that the TB incidence began declining around 1998 for the IDA, IBRD, and Blend dataset while the changepoint for the IDA only dataset was later, around 2001.



BIC as a function of interrupted year: Log transformed removing heavy influence countries

The BIC curves excluding the heavy influence countries are very similar to the curve including heavy influence countries. They show a clear minimum for both curves around 2000 with the IDA only curve having a minimum that is slightly later (2001).



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

The regression results excluding heavy influence countries is similar to that which included the heavy influence countries with the IDA only dataset now displaying a changepoint that is slightly later than the analysis without heavy influence countries (2001 excluding heavy influence countries, 1999 including heavy influence countries).

IDA, IBRD, Blend countries:

Year: 2000

β_2 (interrupted intercept): -0.00318 (p=0.7660)

β_3 (interrupted slope): -0.01882 (p<0.0001)

IDA only countries: same as before since no heavy influence countries

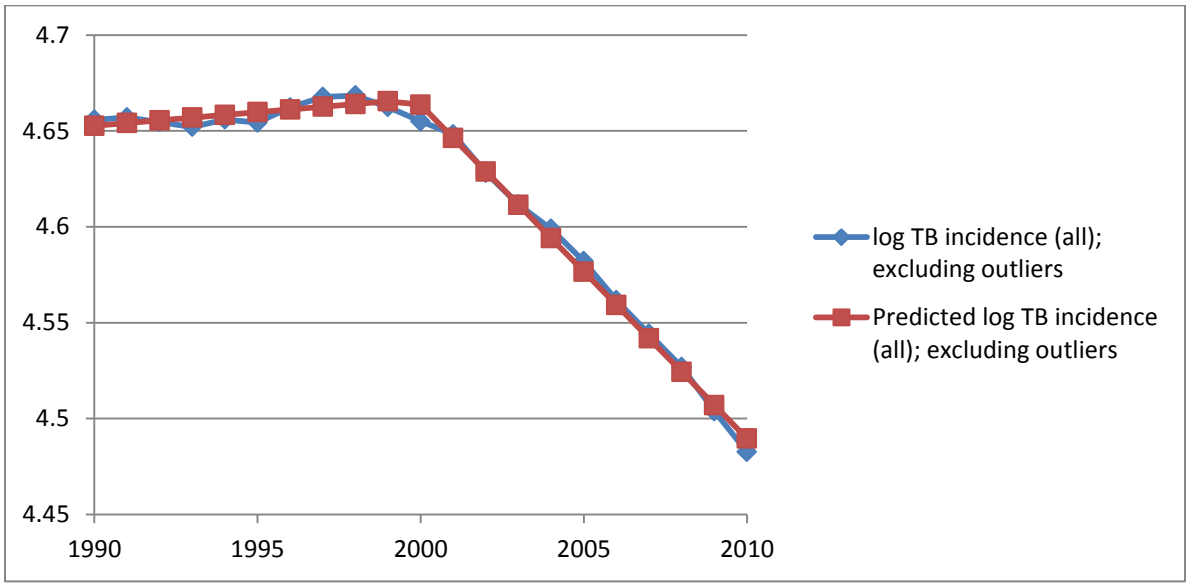
Year: 2001

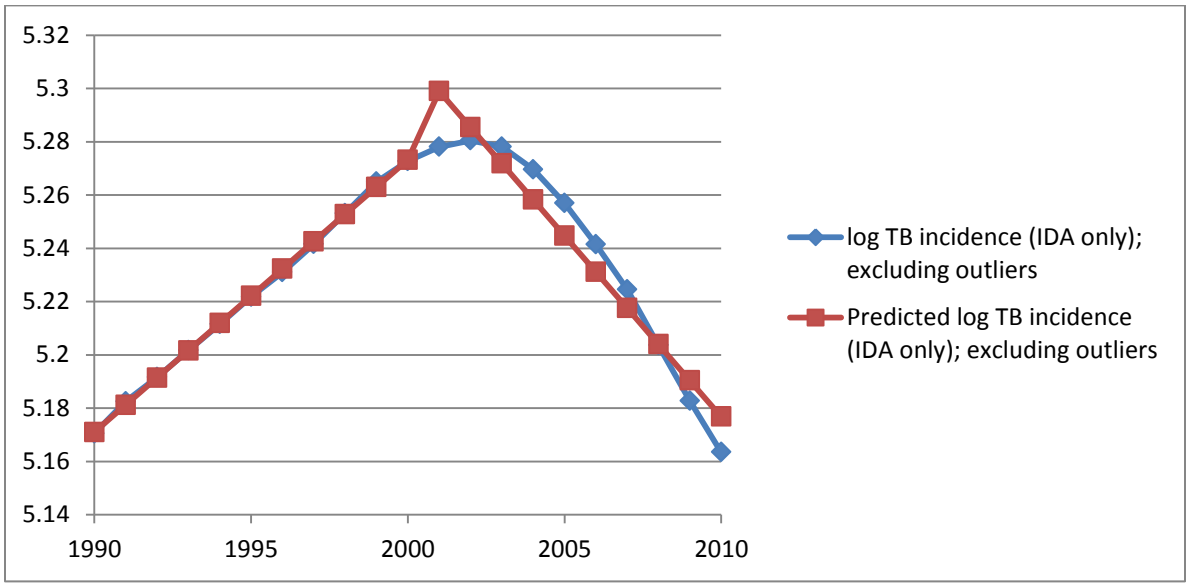
β_2 (interrupted intercept: 0.01552 (p=0.1629)

β_3 (interrupted slope): -0.0238 (p<0.0001)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

Overall the data was extremely well fit by the model with an absolute percent deviation of less than 0.2% for all data points for the IDA, IBRD and Blend dataset. For the IDA only dataset, all but the 2001 data point had an absolute percent deviation less than 0.2%.





Adding Non-Linear Fixed Effect:

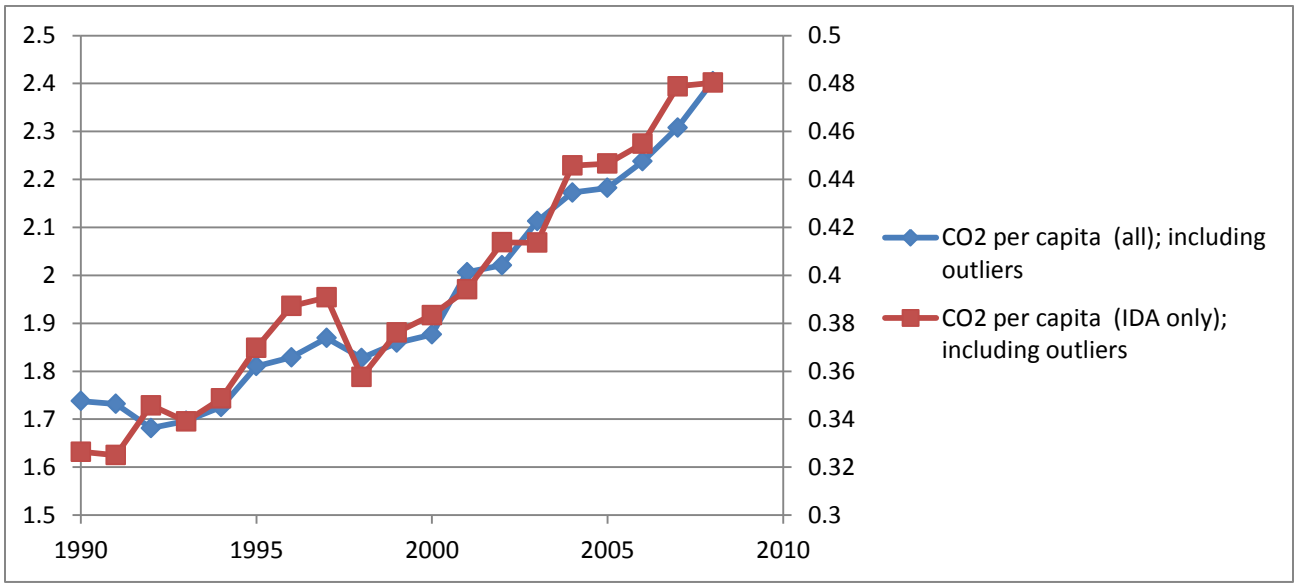
When the fixed effect of year^2 was added to the model for the IDA, IBRD and Blend dataset as well as the IDA only dataset, the conclusions were virtually unchanged. For the IDA, IBRD and Blend data set there was a still a statistically significant change in the TB incidence in 2001 (p=0.0005) while for the IDA only dataset the p-value was now 0.008, exceeding the Bonferroni threshold for statistical significance.

Target 7A Indicator CO2 emissions (metric tons per capita)

Conclusion: Neither dataset displayed a statistically significant acceleration or deceleration.

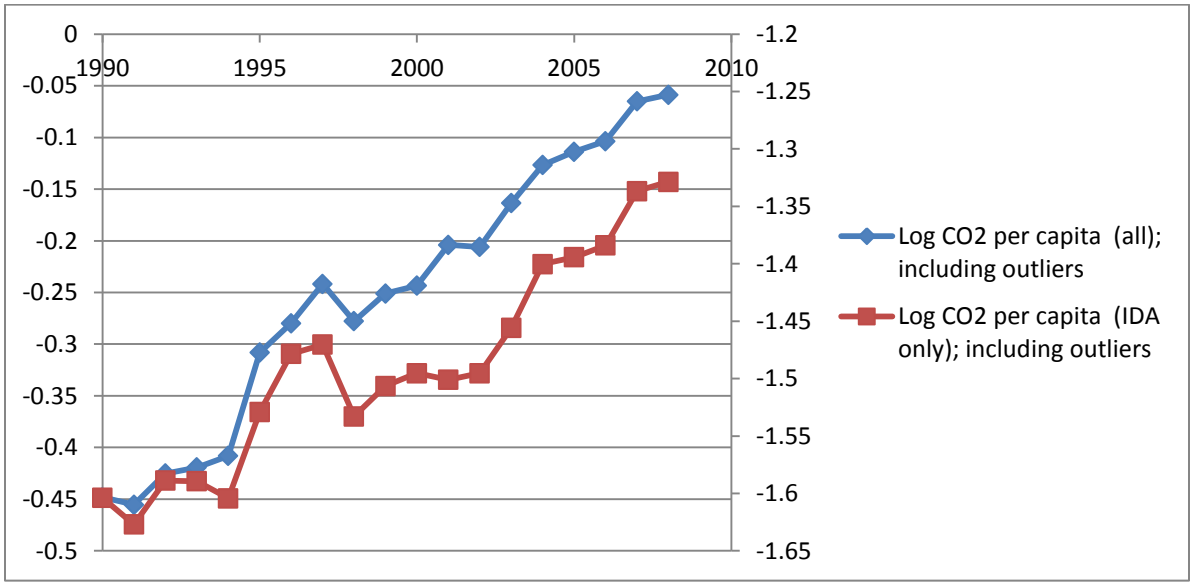
Non-transformed data:

The non-transformed data shows a noisy curve for the IDA, IBRD, Blend countries with a possible acceleration in the CO2 per capita starting around 1999. The IDA only dataset has a clear drop from 1997 to 1998 (possibly related to the Asia financial crisis) and then an increase again starting in 1998.



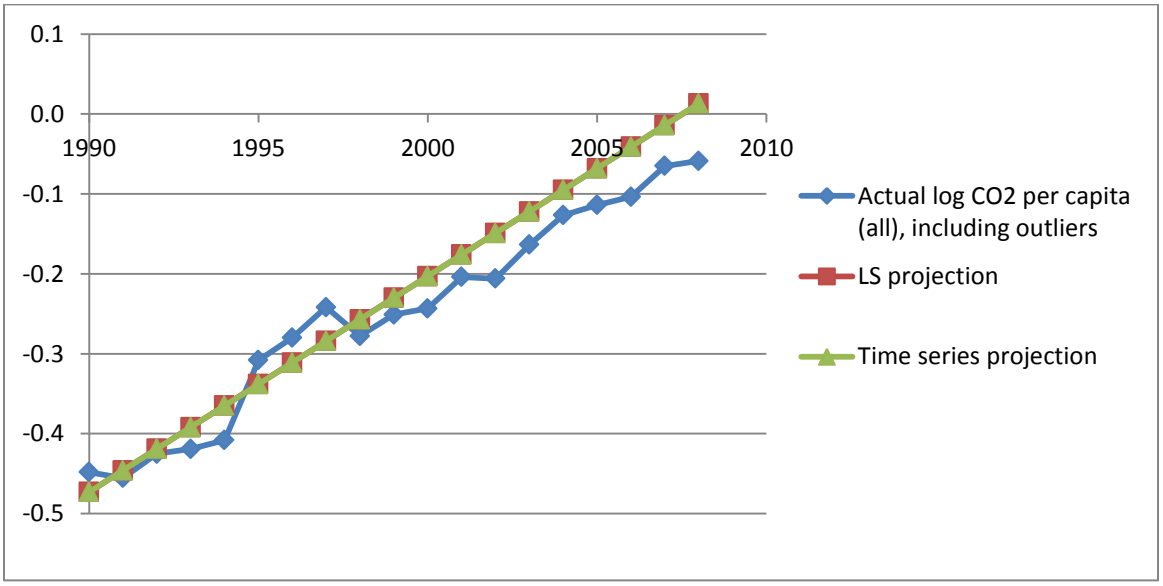
Transformed data:

The transformed data appears less noisy than the non-transformed. It also shows a possible acceleration in the IDA, IBRD, Blend countries starting around 1999. The IDA only dataset has a clear drop from 1997 to 1998 (possibly related to the Asia financial crisis) and then an increase again starting in 1998.



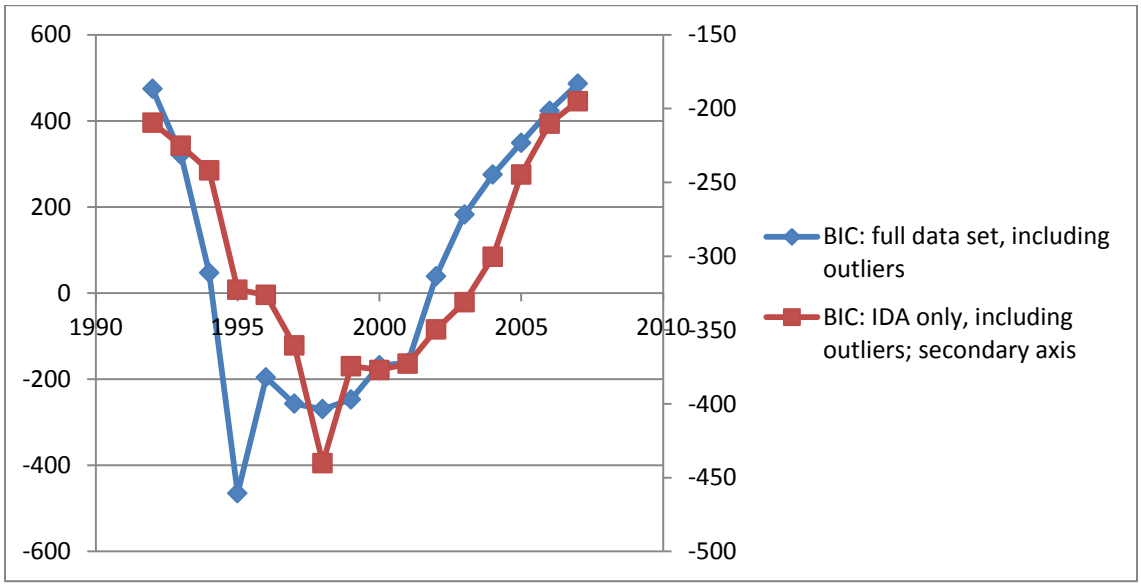
Transformed data: Comparison to least squares regression

The comparison of the actual data to the least squares and the time series projection displays clearly that there was a deviation from the linear trend both before and after 2000.



BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.

The BIC curve for the IDA, IBRD and Blend dataset shows a different pattern than many of the other datasets in that the minimum is not centered around the other lowest points and that the IDA only minimum is more than 2 years apart from the IDA, IBRD and Blend minimum. The minimum for the IDA, IBRD, IDA dataset is 1995 while the minimum for the IDA only is clearly 1998 where the IDA only dataset has a more typical BIC curve.



Estimated coefficients from linear mixed model for optimal year.

IDA, IBRD, Blend countries:

Year: 1995

β_2 (interrupted intercept): 0.08102 (p=0.0399)

β_3 (interrupted slope): 0.007802 (p=0.4236)

IDA only countries:

Year: 1998

β_2 (interrupted intercept): -0.08284 (p=0.0275)

β_3 (interrupted slope): -0.00061(p=0.9439)

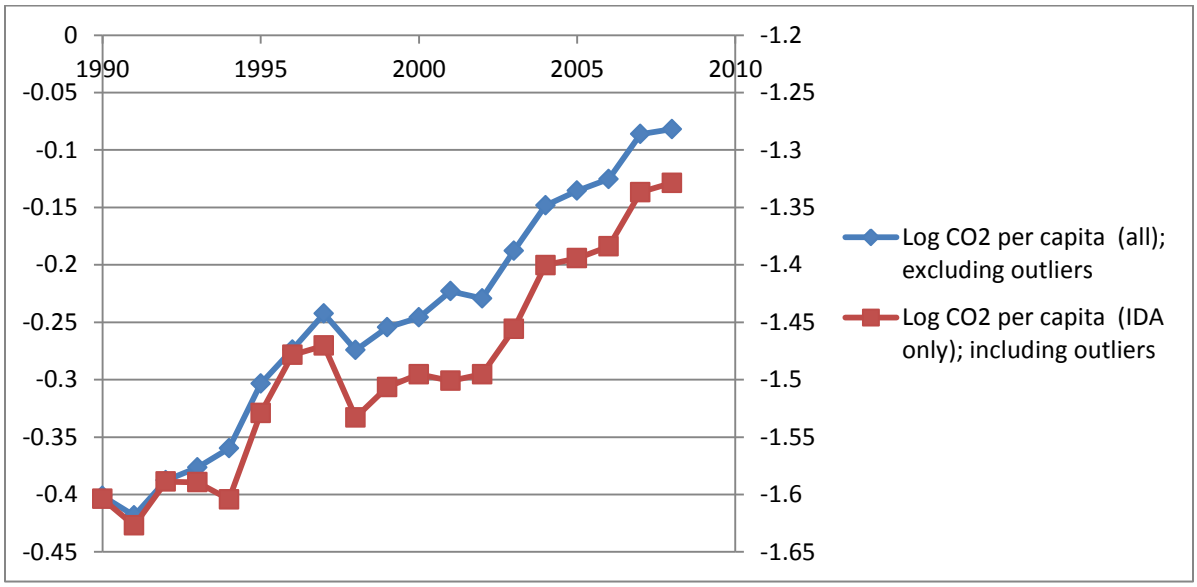
Heavy Influence Countries Identified:

IDA, IBRD, Blend: Equatorial Guinea, Namibia

IDA Only: None

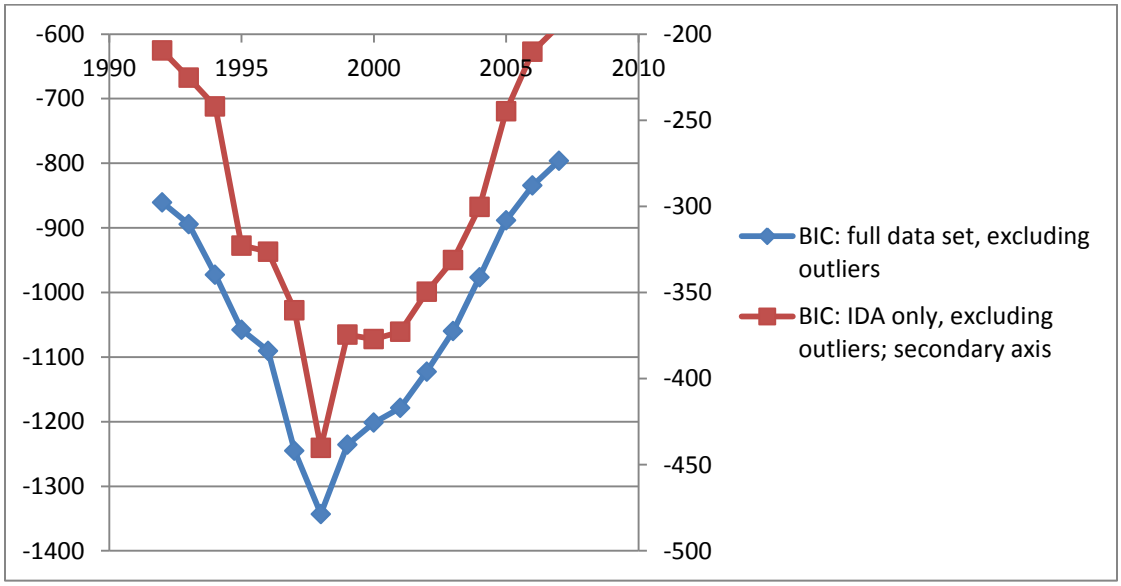
Transformed data (heavy influence countries removed):

After removing the heavy influence countries the curve for the IDA, IBRD and Blend dataset looks very similar to the curve that included the heavy influence countries except that there is less indication of a changepoint. Since there were no IDA only heavy influence countries, the curve is identical.



BIC as a function of interrupted year: Log transformed removing heavy influence countries

The BIC curves with the heavy influence countries removed look much more typical with a clear minimum at 1998 for both curves.



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

The regression results are similar to the previous regression results in that there is no significant interrupted intercept or slope in either dataset.

IDA, IBRD, Blend countries:

Year: 1998

β_2 (interrupted intercept): -0.0507 (p=0.0306)

β_3 (interrupted slope): -0.00455 (p=0.4168)

IDA only countries: same as before since no heavy influence countries

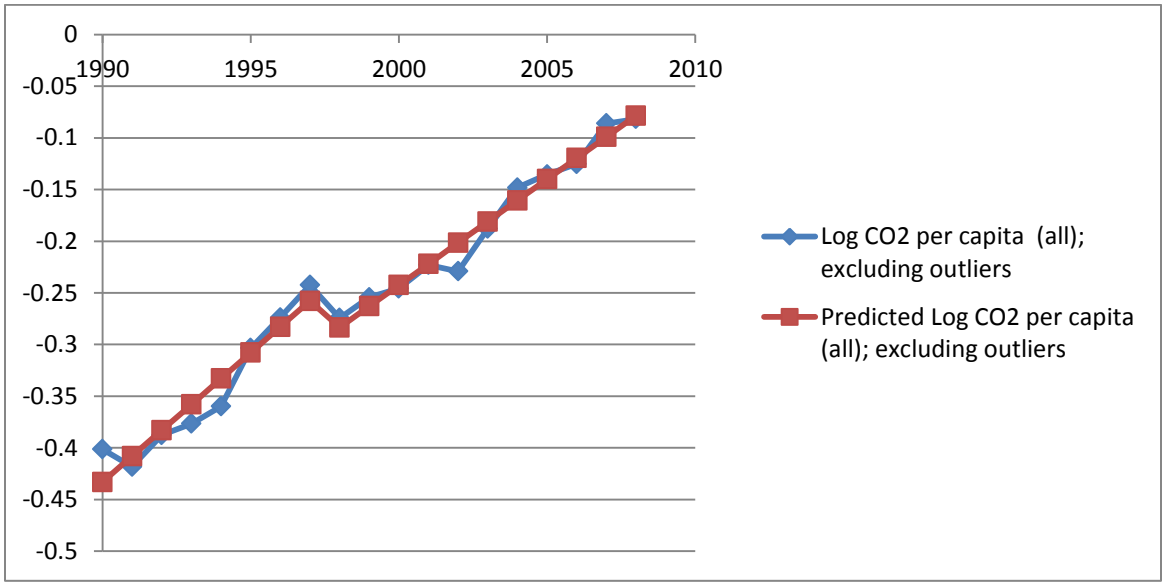
Year: 1998

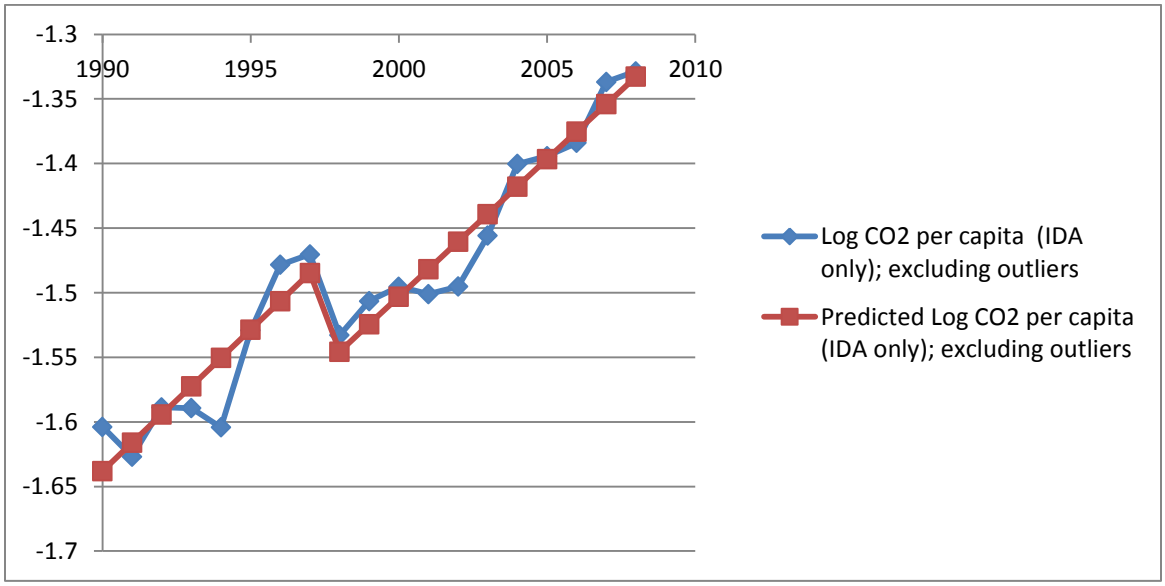
β_2 (interrupted intercept): -0.08284 (p=0.0275)

β_3 (interrupted slope): -0.00061(p=0.9439)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

Overall the data was well fit by the model. While there were some data points that had absolute percent deviations exceeding 5% this was largely a reflection of the fact that the data itself had points near 0.





Adding Non-Linear Fixed Effect:

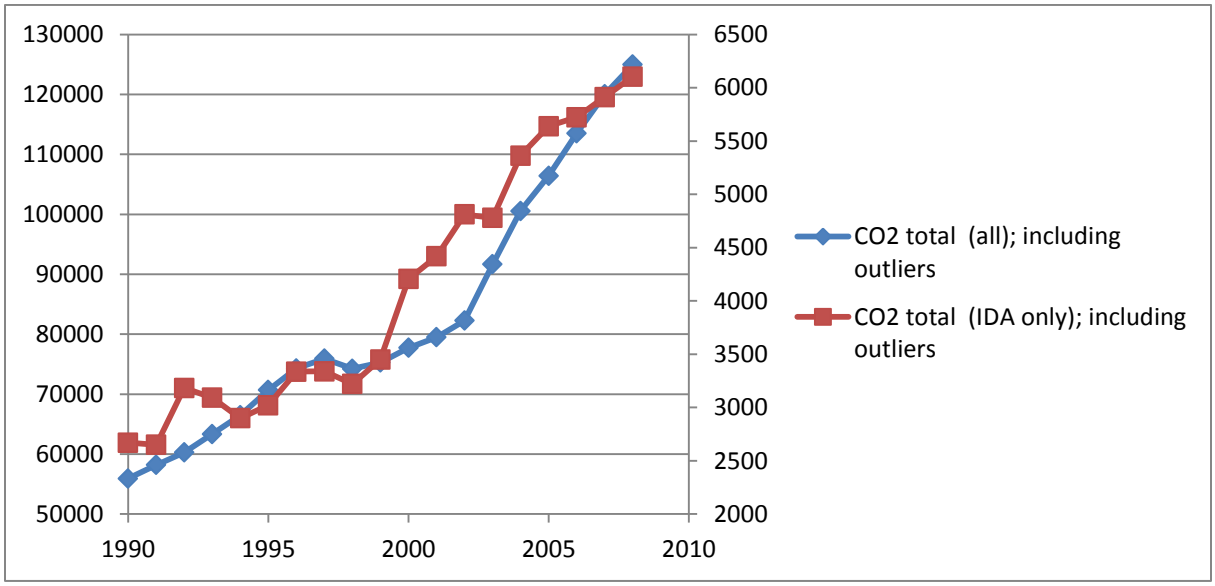
When the fixed effect of year^2 was added to the model the conclusions were unchanged though for the IDA, IBRD and Blend dataset the coefficient for the interrupted slope approached significance (p=0.0081, slightly exceeding the Bonferroni adjusted p-value threshold of 0.0029).

Target 7A Indicator CO2 total (ktons)

Conclusion: Neither dataset displayed a statistically significant acceleration or deceleration.

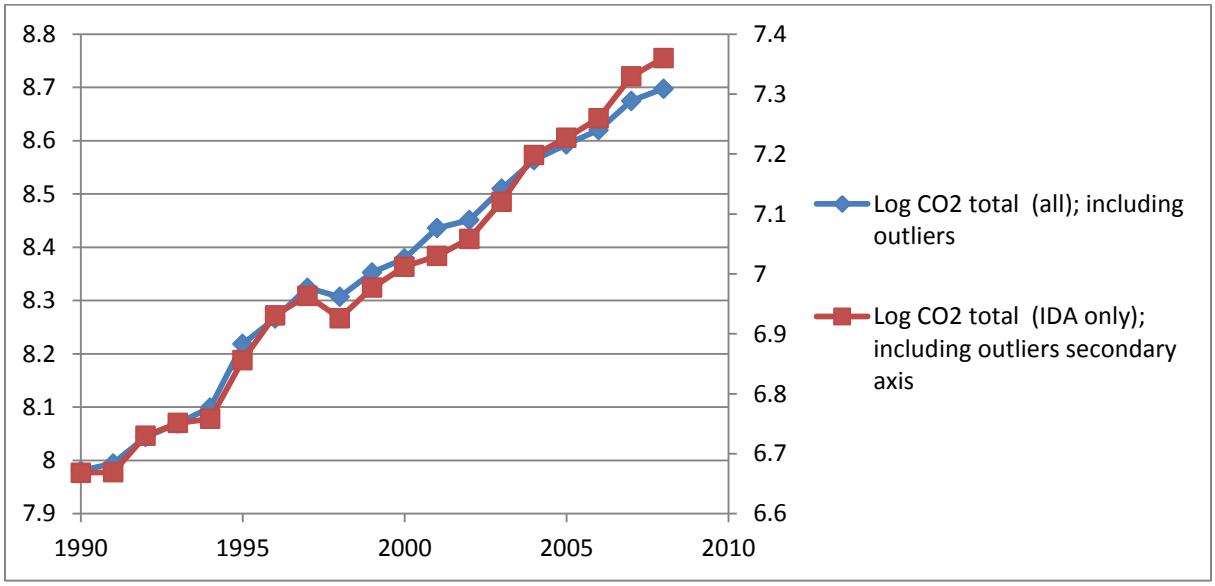
Non-transformed data:

The non-transformed data displayed an increase in slope around 2002 for the IDA, IBRD and Blend dataset while the IDA only dataset appears to have an increase in slope starting around 1999.



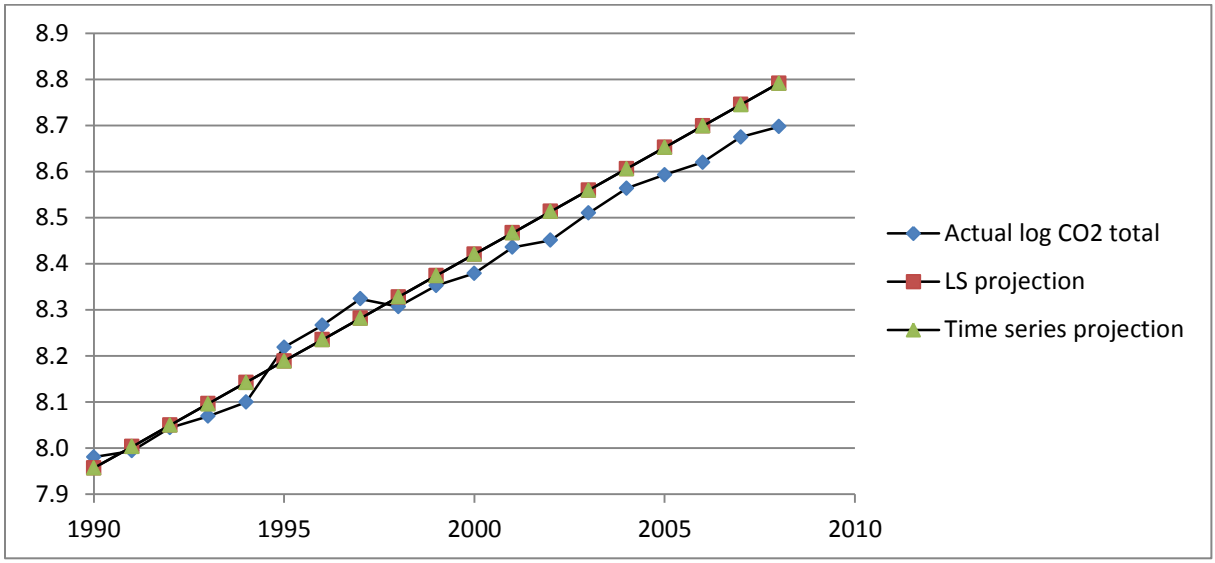
Transformed data:

The transformed data shows a step drop around 1998 for both the IDA only and the IDA, IBRD, and Blend dataset that may be related to the Asian financial crisis.



Transformed data: Comparison to least squares regression

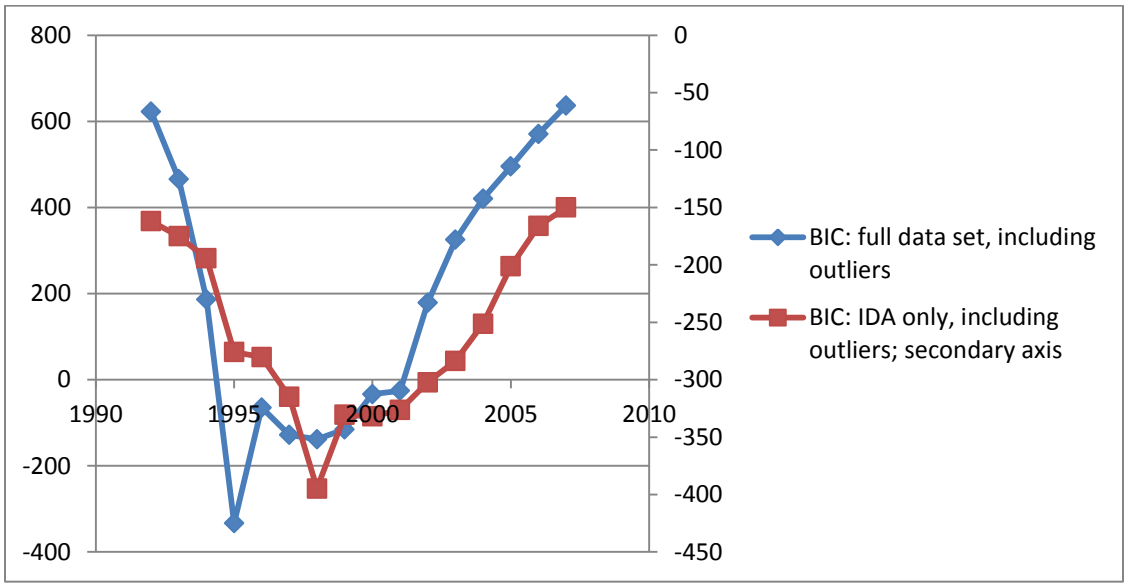
The comparison of the actual data to the least squares and the time series projection displayed there was a systematic deviation from the linear trend consistently after 2001. Note that the time series fit in this case was a constant slope (equivalent to linear regression).



BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.

The BIC curve for the IDA, IBRD and Blend dataset is unusual in that the minimum it is not centered around the other lowest points and that the minimum for this curve (1995 minimum) is more than 2

years from the minimum for the IDA only curve (1998 minimum). This pattern was not seen generally but, not surprisingly, was the same pattern observed in the CO2 per capita curves.



Estimated coefficients from linear mixed model for optimal year.

IDA, IBRD, Blend countries:

Year: 1995

β_2 (interrupted intercept): 0.08461 (p=0.0326)

β_3 (interrupted slope): 0.005732 (p=0.5573)

IDA only countries:

Year: 1998

β_2 (interrupted intercept): -0.07692 (p=0.0429)

β_3 (interrupted slope): -0.00061(p=0.9444)

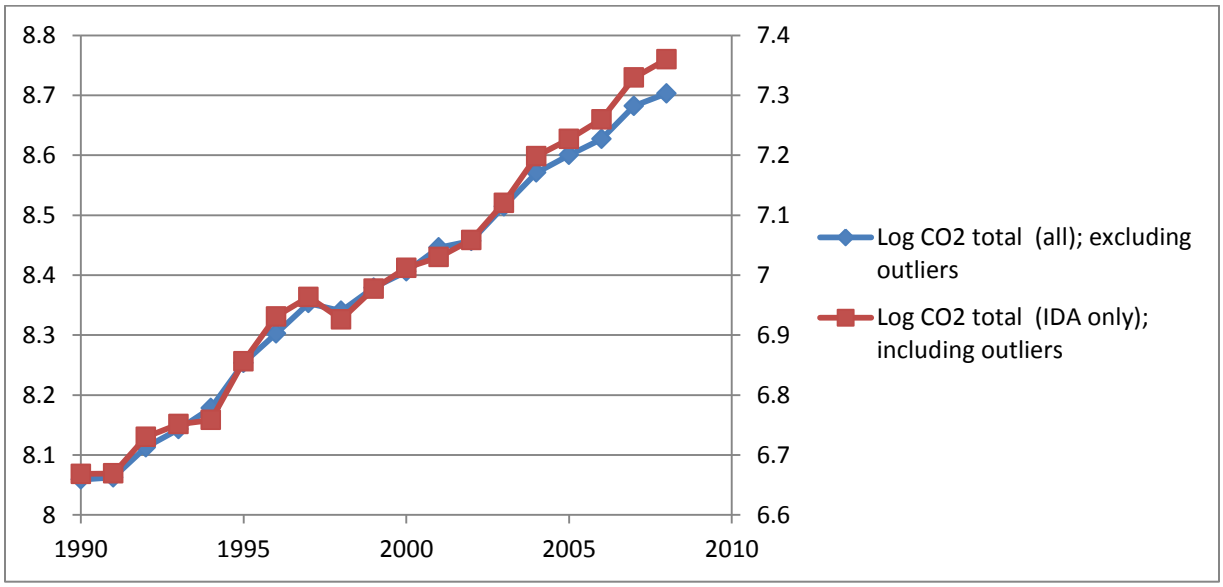
Heavy Influence Countries Identified:

IDA, IBRD, Blend: Equatorial Guinea, Namibia

IDA Only: None

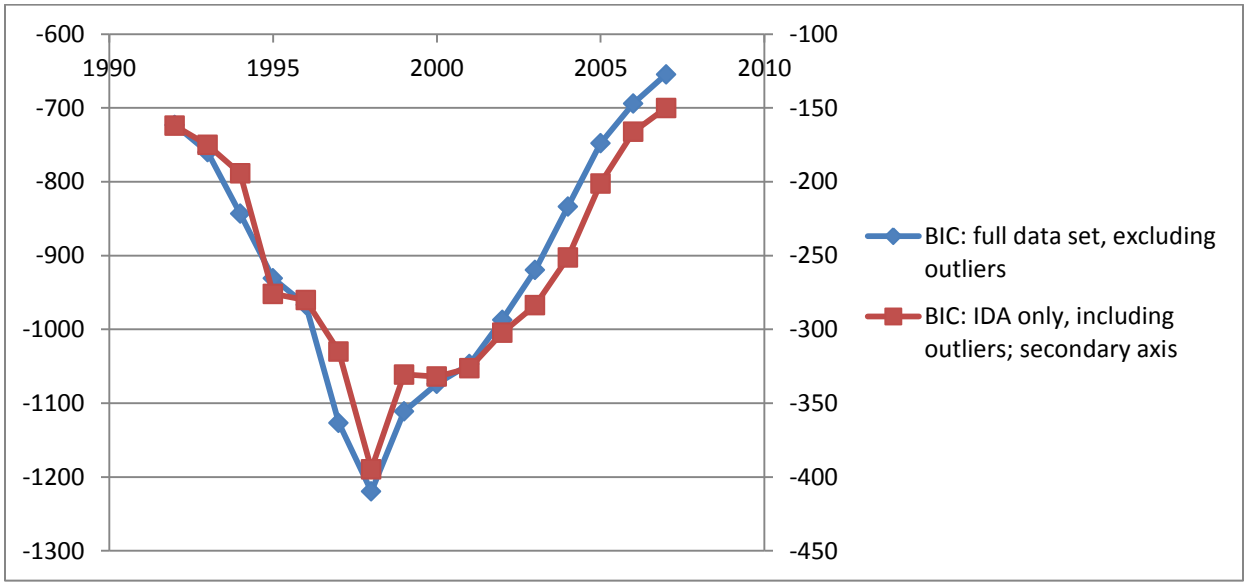
Transformed data (heavy influence countries removed):

After removing the heavy influence countries the curve for the IDA, IBRD and Blend dataset looks very similar to the curve with the heavy influence countries. Since there were no IDA only heavy influence countries, the curve is identical.



BIC as a function of interrupted year: Log transformed removing heavy influence countries

The BIC curves with the heavy influence countries removed look much more typical with a clear minimum at 1998 for both curves.



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

The regression results are similar to the previous regression results in that there is neither a significant interrupted intercept or slope in either dataset. The IDA only results are the same as the previous results since there were no heavy influence countries in the IDA only analysis.

IDA, IBRD, Blend countries:

Year: 1998

β_2 (interrupted intercept): -0.04845 (p=0.0396)

β_3 (interrupted slope): -0.00687 (p=0.227)

IDA only countries:

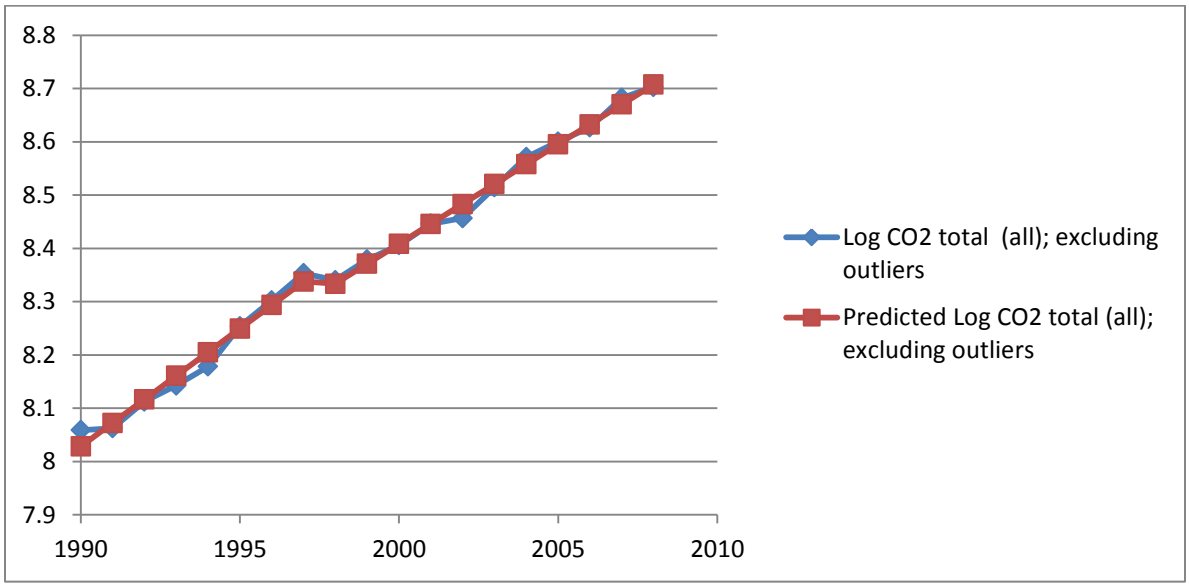
Year: 1998

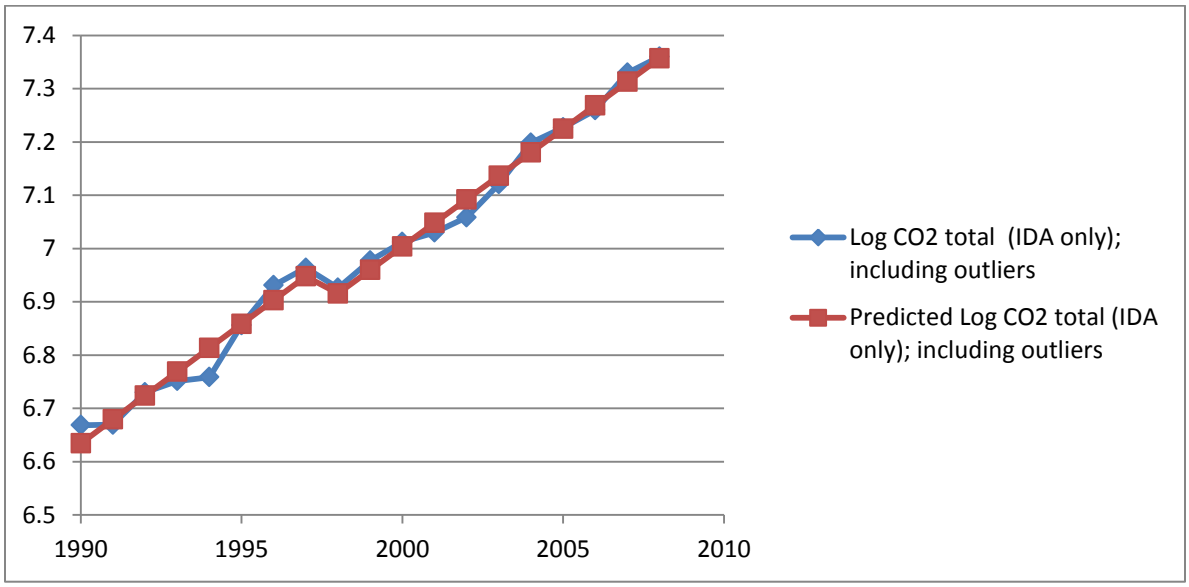
β_2 (interrupted intercept): -0.07692 (p=0.0429)

β_3 (interrupted slope): -0.00061(p=0.9444)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

Overall the data was well fit by the model with the absolute percent deviation below 1% for all data points.





Adding Non-Linear Fixed Effect:

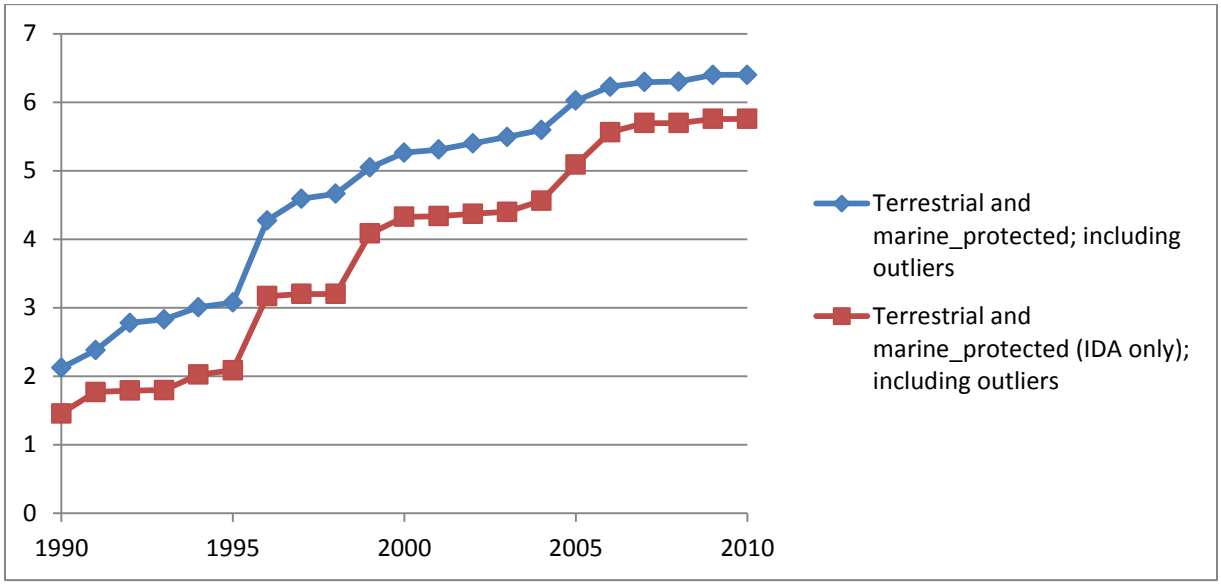
When the fixed effect of year^2 was added to the model the conclusions were unchanged though the coefficient for the IDA, IBRD and Blend dataset for the interrupted slope approached significance (p=0.0081 where the Bonferroni adjusted significant p-value threshold was 0.0029). This is the same observation that was made for the CO2 per capita dataset.

Target 7B Indicator Proportion of terrestrial and marine areas protected

Conclusion: Neither dataset had an acceleration or deceleration after removing heavy influence countries.

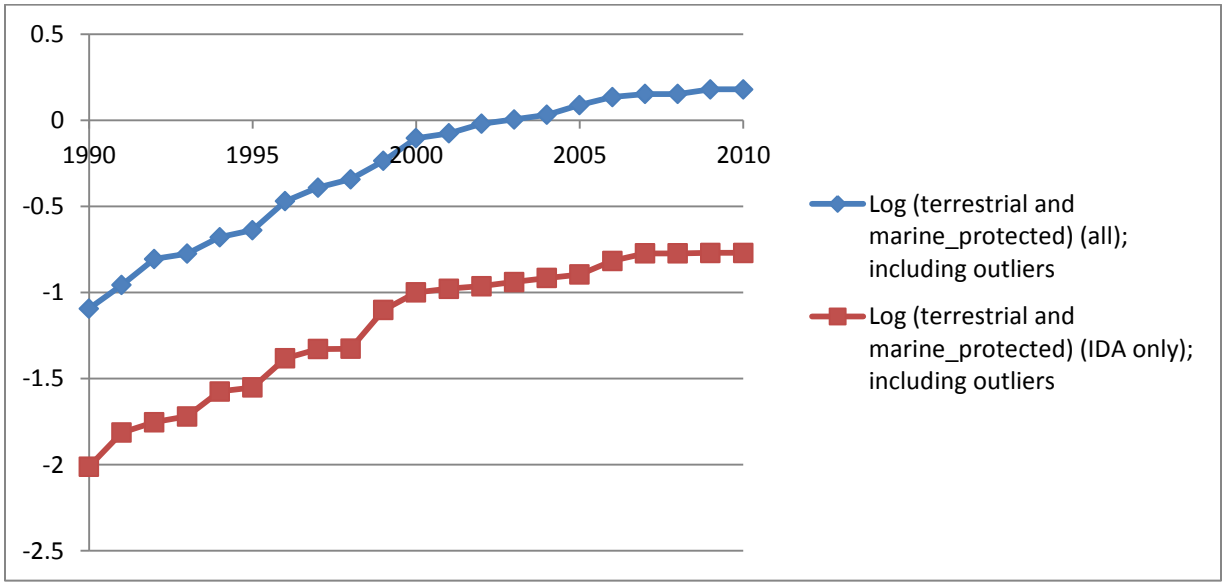
Non-transformed data:

The non-transformed data displays a substantial jump (interrupted intercept) in 1996 for both the IDA only and the IDA, IBRD and Blend dataset.



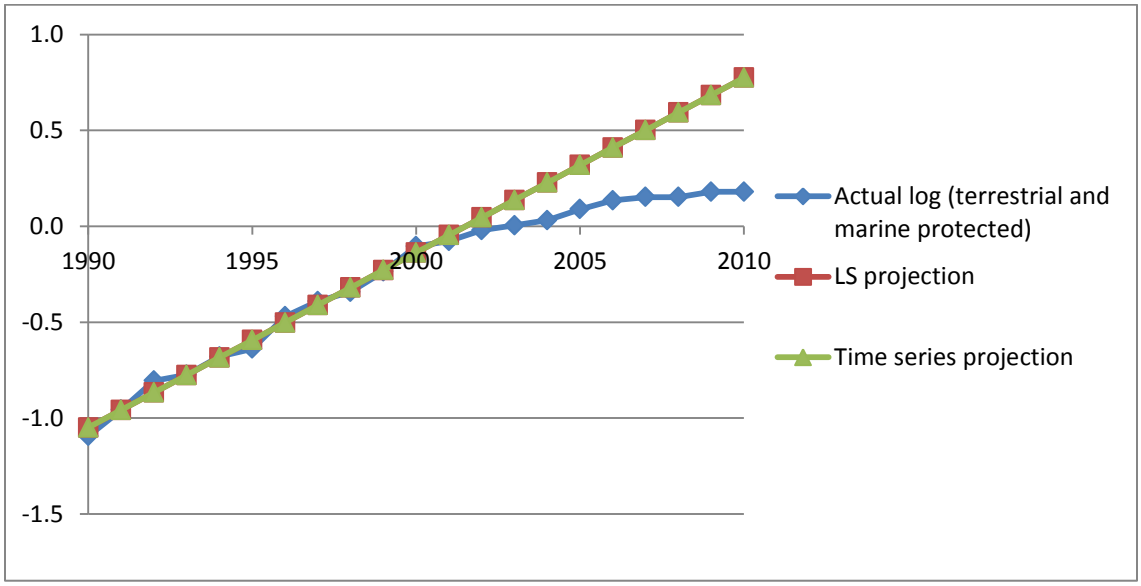
Transformed data:

The transformed data shows a slope change starting around 2000 for both the IDA only and the IDA, IBRD and Blend dataset. The difference in interpretation of the transformed and non-transformed datasets may be related to the fact that the transformation crosses the 0 point thus producing positive and negative values that may be cancelling out in the population curve.



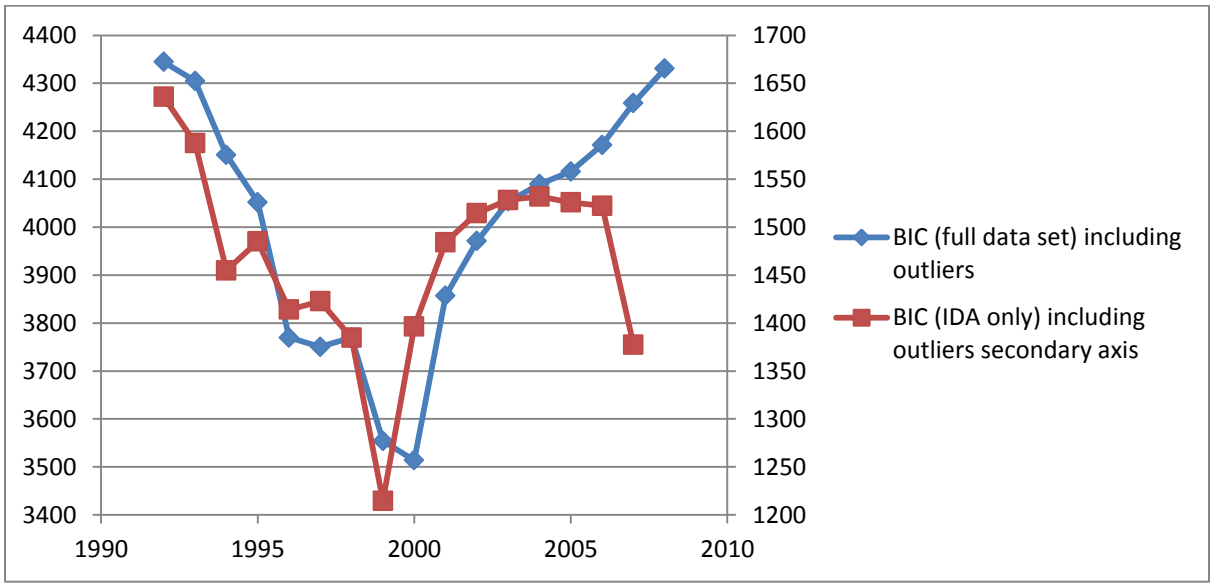
Transformed data: Comparison to least squares regression

The comparison of the actual data to the least square projection shows a clear deviation from the 1990-1999 pace by 2003. Note that the time series fit for this data was a trend, equivalent to linear regression.



BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.

The BIC curve displays a clear minimum at 2000 for the IDA, IBRD and Blend dataset while the IDA only dataset is complicated by a the global minimum in 1999 and the drop in 2007 (model did not converge for 2008).



Estimated coefficients from linear mixed model for optimal year.

IDA, IBRD, Blend countries:

Year: 2000

β_2 (interrupted intercept): 0.05015 (p= 0.5817)

β_3 (interrupted slope): -0.06066 (p=0.0009)

IDA only countries:

Year: 1999

β_2 (interrupted intercept): 0.1264 (p= 0.4456)

β_3 (interrupted slope): -0.05539 (p=0.0791)

Heavy Influence Countries Identified:

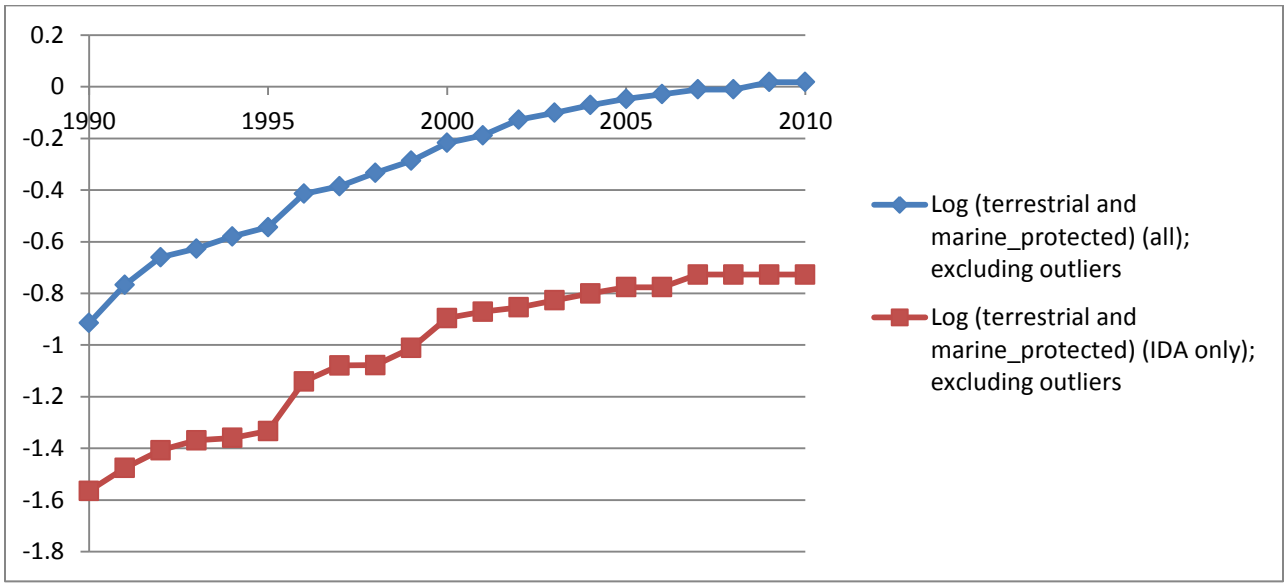
Note: This dataset had far more heavy influence countries than was typical in the MDG datasets.

IDA, IBRD, Blend: Congo, Rep., Jordan, Ecuador, Kiribati, Equatorial Guinea, Lebanon, Guatemala, Tonga

IDA Only: Congo, Rep., Kiribati, Somalia, Sudan, Tonga

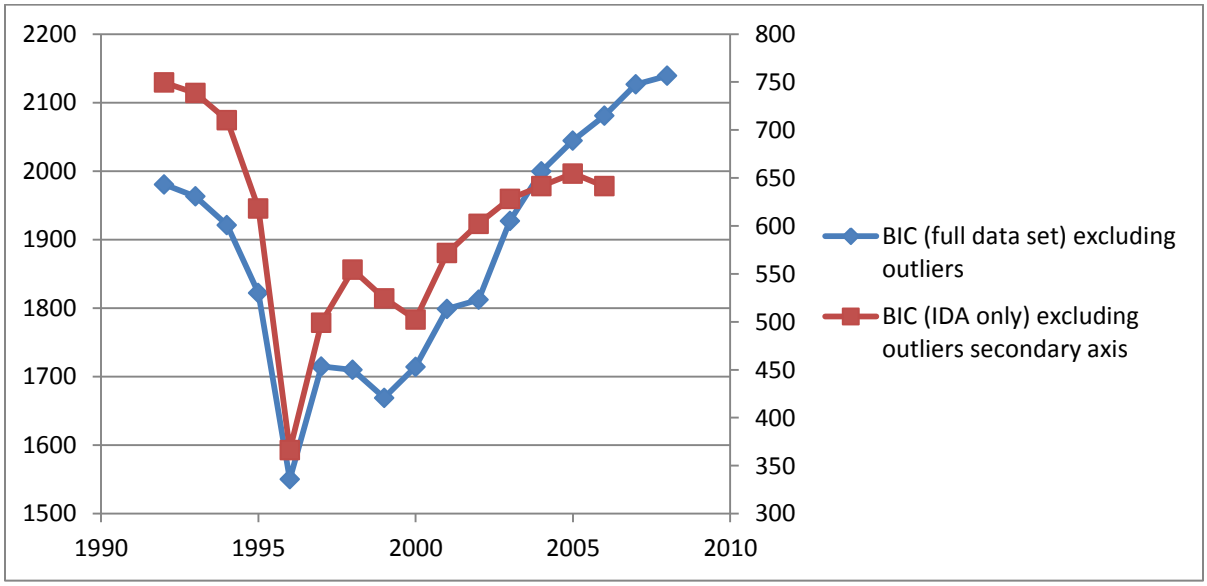
Transformed data (heavy influence countries removed):

After removing the heavy influence countries there appears to be a reduction in the slope (interrupted slope) for the IDA, IBRD and Blend dataset starting around 2000 while the IDA only curve appears to have a step increase (interrupted intercept) around 1996.



BIC as a function of interrupted year: Log transformed removing heavy influence countries

The BIC curves with the heavy influence countries removed show clear minimums in 1996 for both curves, substantially earlier than the curves with the heavy influence countries included where the minimums for the BIC curves were 1999/2000.



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

The regression results show no significant interrupted slopes or intercepts for the datasets after heavy influence countries have been removed.

IDA, IBRD, Blend countries:

Year: 1996

β_2 (interrupted intercept): 0.06475(p= 0.3363)

β_3 (interrupted slope): -0.03754 (p=0.0199)

IDA only countries:

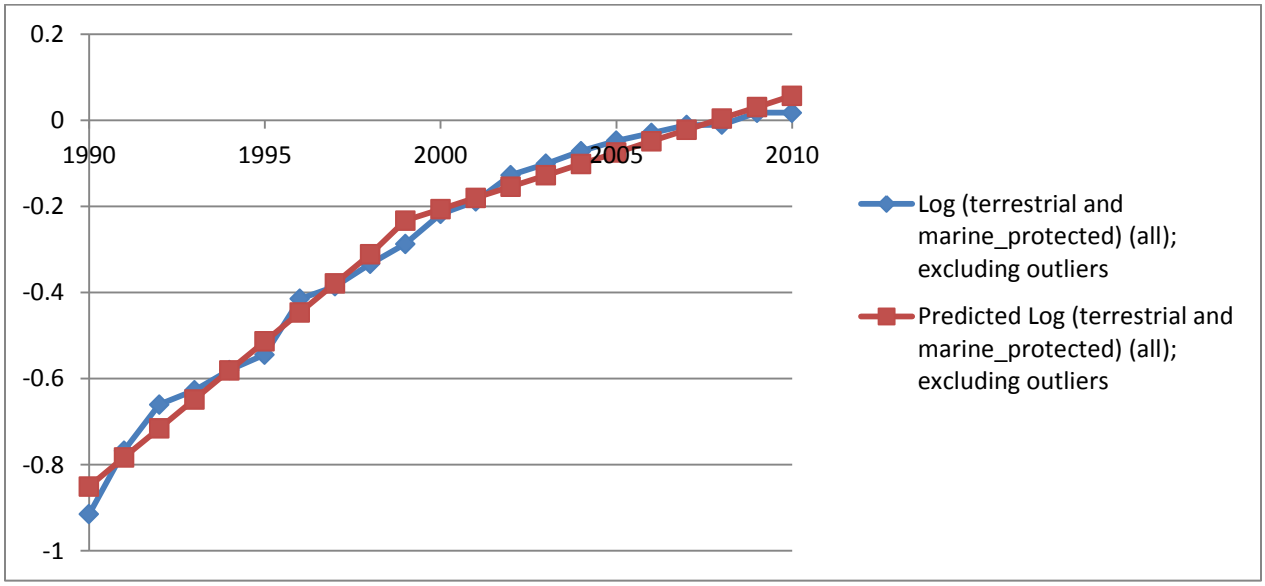
Year: 1996

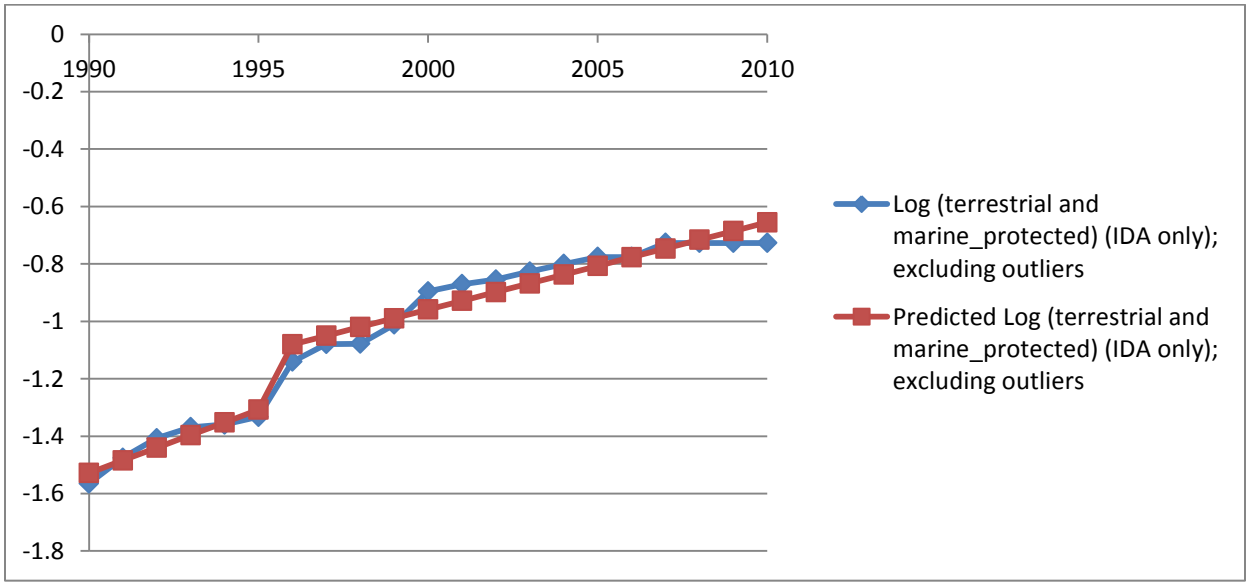
β_2 (interrupted intercept): 0.1834 (p=0.1598)

β_3 (interrupted slope): -0.01377 (p=0.4965)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

Overall the data was well fit by the model for both dataset but the absolute percent deviation was large for some data points due to the data values being near zero.





Adding Non-Linear Fixed Effect:

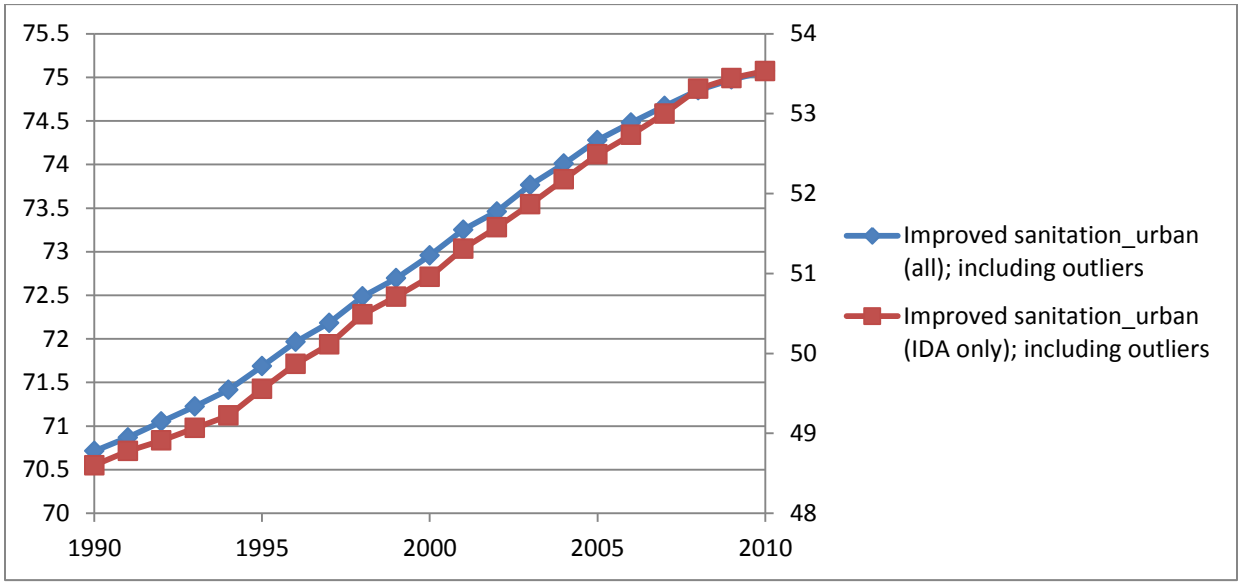
There was no change in the conclusions when the fixed effect of year^2 was introduced to the models where heavy influence countries were removed.

Target 7C Indicator Improved sanitation (urban)

Conclusion: There was a deceleration in the rate of improved sanitation for IDA, IBRD and Blend countries starting around 2006 despite the level not being near universal coverage. The coefficients for the IDA only dataset were below the Bonferroni adjusted levels for statistical significance.

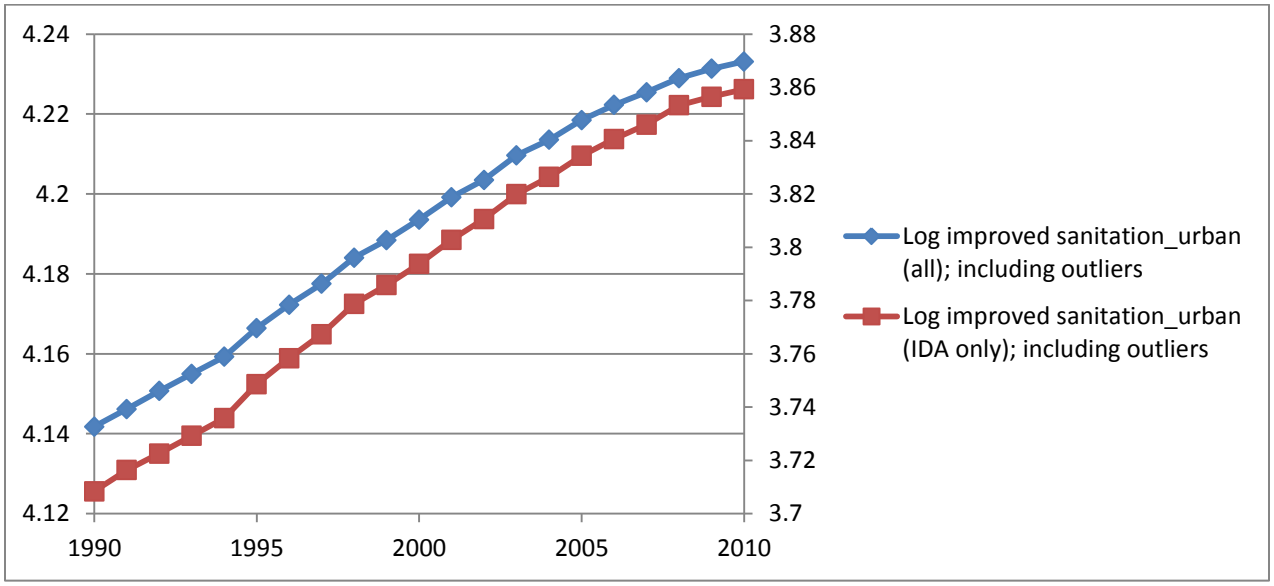
Non-transformed data:

The non-transformed data displays a relatively linear curve for both datasets.



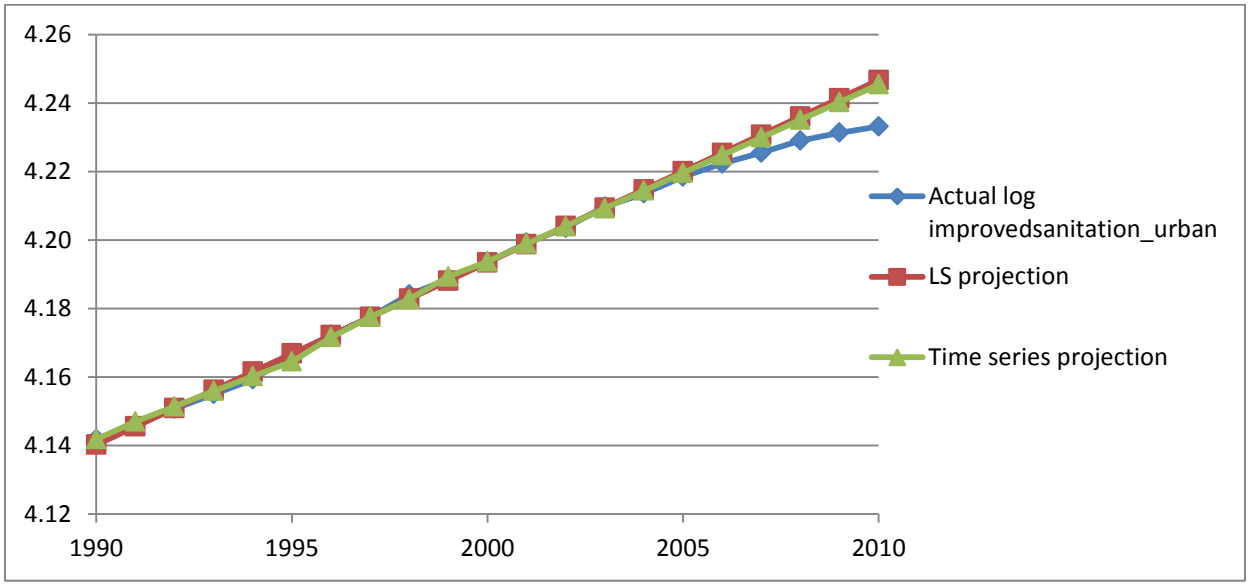
Transformed data:

The transformed data suggested minor slope changes around 1994/1995 and 2005 for both the IDA only and IDA, IBRD, and Blend dataset.



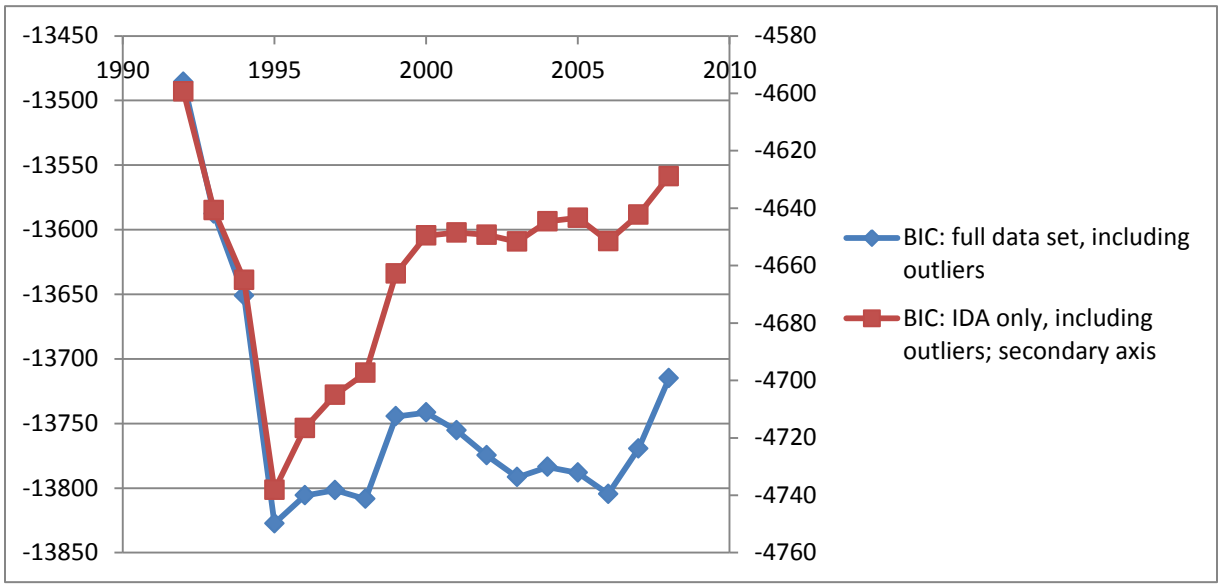
Transformed data: Comparison to least squares regression

The comparison of the actual data to the least square projection shows a clear deviation from the 1990-1999 pace by 2007 with some deceleration in the actual data versus the 1990-1999 pace. Note that the time series fit for this data was a trend, equivalent to linear regression.



BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.

The BIC curve displays a clear minimum at 1995 for both curves though the shape of the curves themselves are somewhat atypical compared to other BIC curves, suggesting the impact of heavy influence countries.



Estimated coefficients from linear mixed model for optimal year.

IDA, IBRD, Blend countries:

Year: 1998

β_2 (interrupted intercept): 0.004318 (p= 0.0043)

β_3 (interrupted slope): -0.00088 (p=0.0096)

IDA only countries:

Year: 1995

β_2 (interrupted intercept): 0.01176 (p=0.0075)

β_3 (interrupted slope): 0.00081 (p=0.6196)

Heavy Influence Countries Identified:

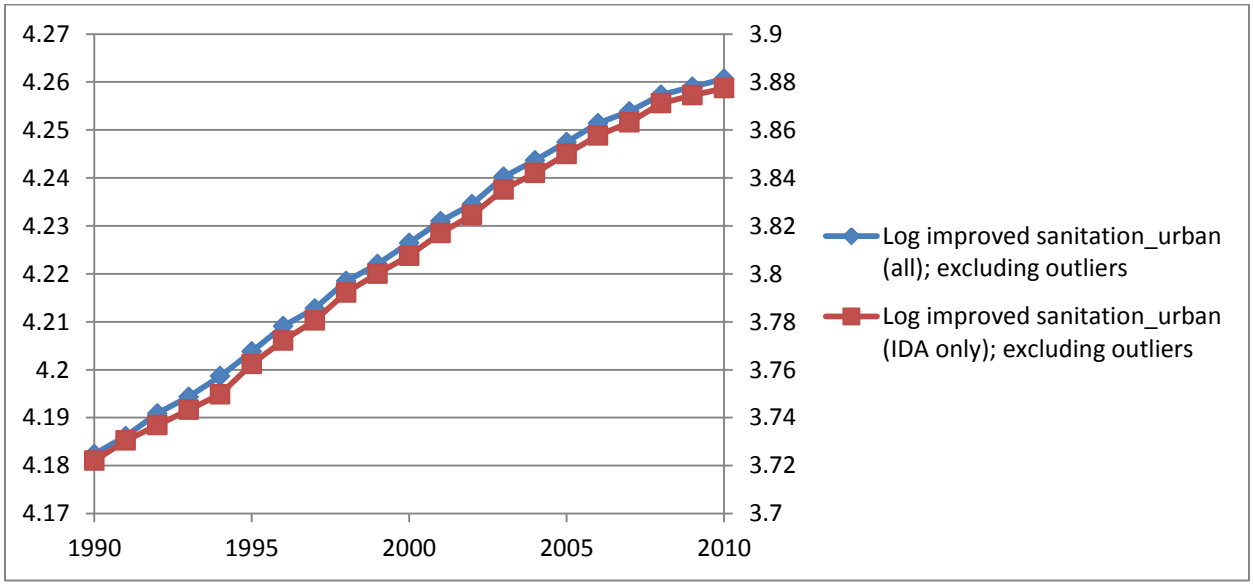
Note: This dataset had far more heavy influence countries than was typical in the MDG datasets.

IDA, IBRD, Blend: Cambodia, Central African Republic, Comoros, Haiti, Tanzania

IDA Only: Central African Republic, Haiti

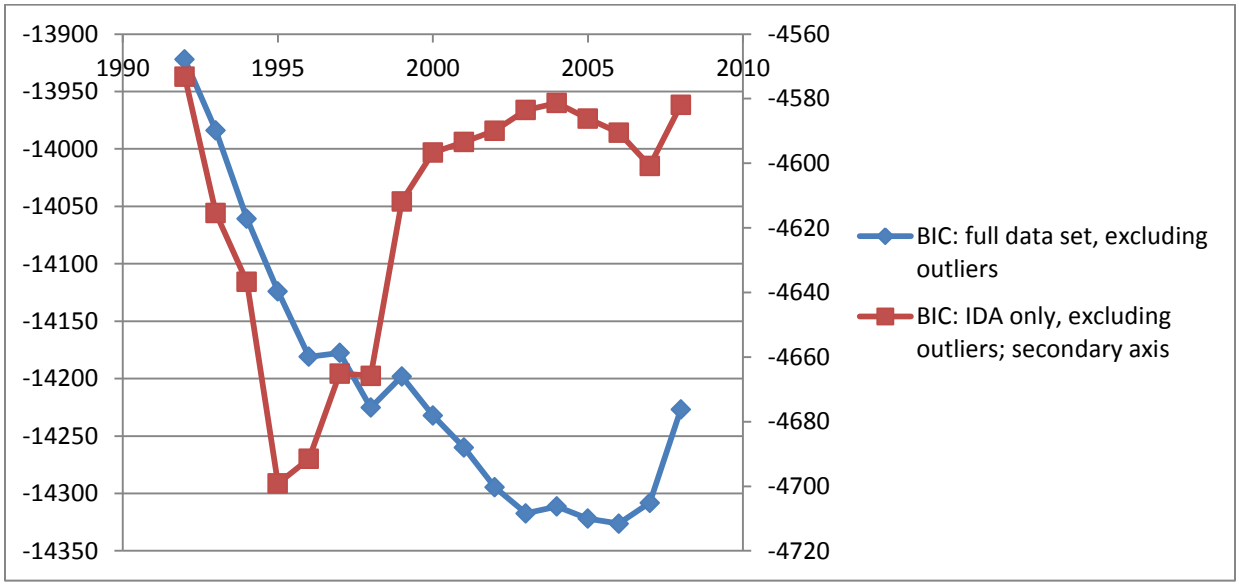
Transformed data (heavy influence countries removed):

After removing the heavy influence countries the datasets continue to appear rather linear with a potential slight deceleration in the IDA, IBRD and Blend dataset starting around 2004.



BIC as a function of interrupted year: Log transformed removing heavy influence countries

The BIC curve for the IDA only dataset shows a clear minimum at 1995 though the shape is atypical of BIC curves in that it is not symmetric. The IDA, IBRD and Blend dataset curve does not have a clear minimum with 2003 to 2007 all in a similar range.



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

The regression results show a significant deceleration in the rate of improved sanitation for IDA, IBRD and Blend countries starting around 2006 despite the level not being near universal coverage. The coefficients for the IDA only dataset were below the Bonferroni adjusted levels for statistical significance.

IDA, IBRD, Blend countries:

Year: 2006

β_2 (interrupted intercept): -0.00105 (p= 0.0853)

β_3 (interrupted slope): -0.00207 (p<0.0001)

IDA only countries:

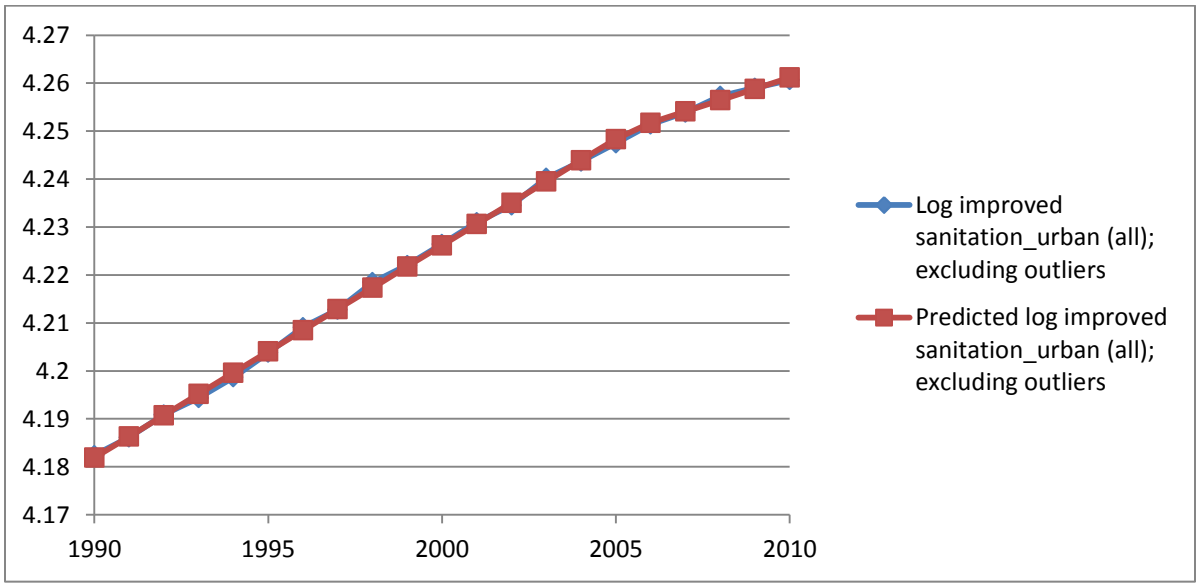
Year: 1995

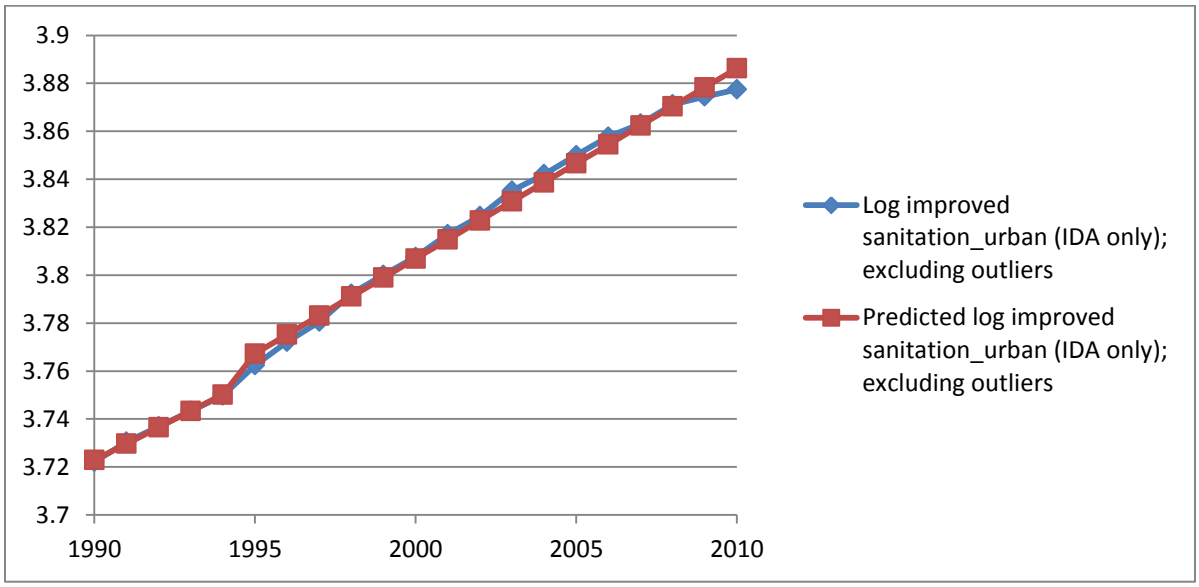
β_2 (interrupted intercept): 0.01028 (p= 0.0073)

β_3 (interrupted slope): 0.001108 (p=0.4725)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

Overall the data was well fit by the model for both dataset with the absolute percent deviation less than 0.2% for all data points.





Adding Non-Linear Fixed Effect:

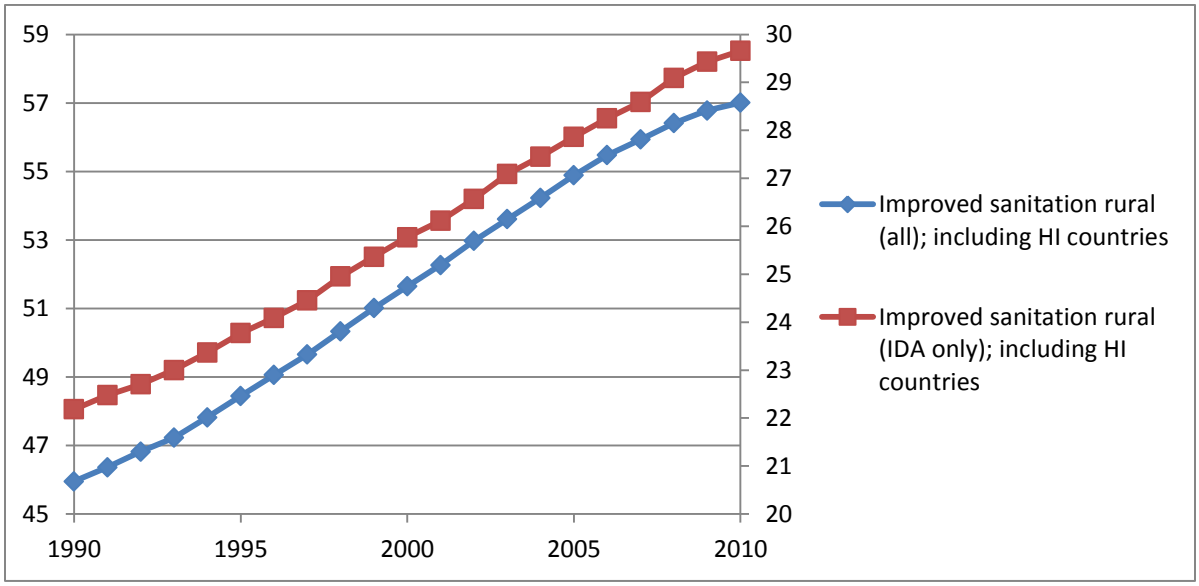
There was no change in the conclusions when the fixed effect of year^2 was introduced to the models where heavy influence countries were removed.

Target 7C Indicator Improved sanitation (rural)

Conclusion: After removing the heavy influence countries, there was a statistically significant deceleration (interrupted slope) in the IDA, IBRD, and Blend dataset starting in 1999.

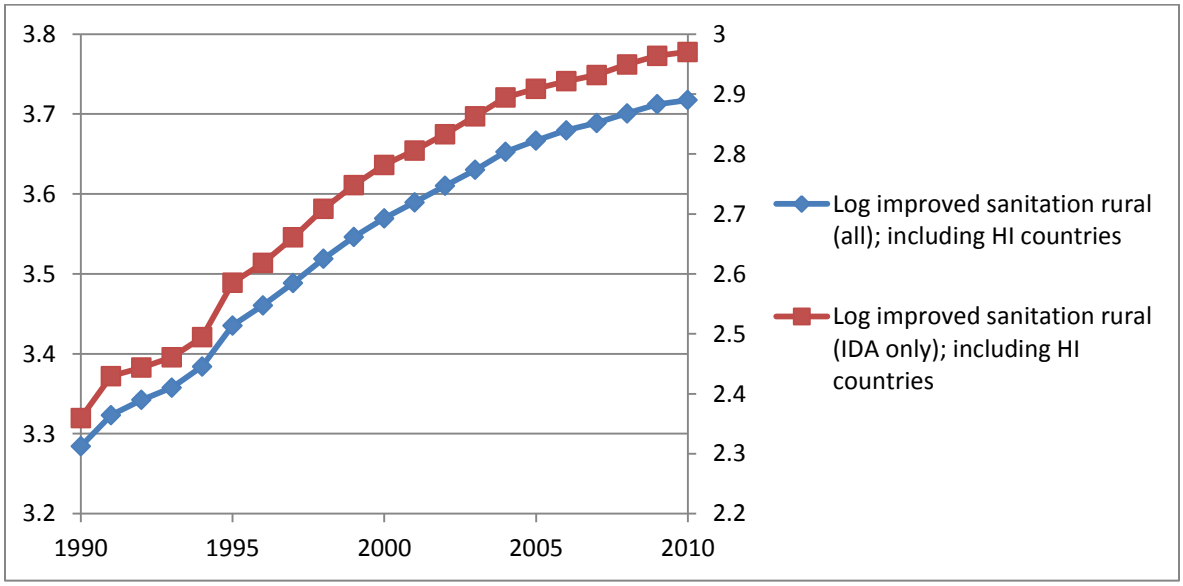
Non-transformed data:

The non-transformed data displays relatively linear curves for both datasets.



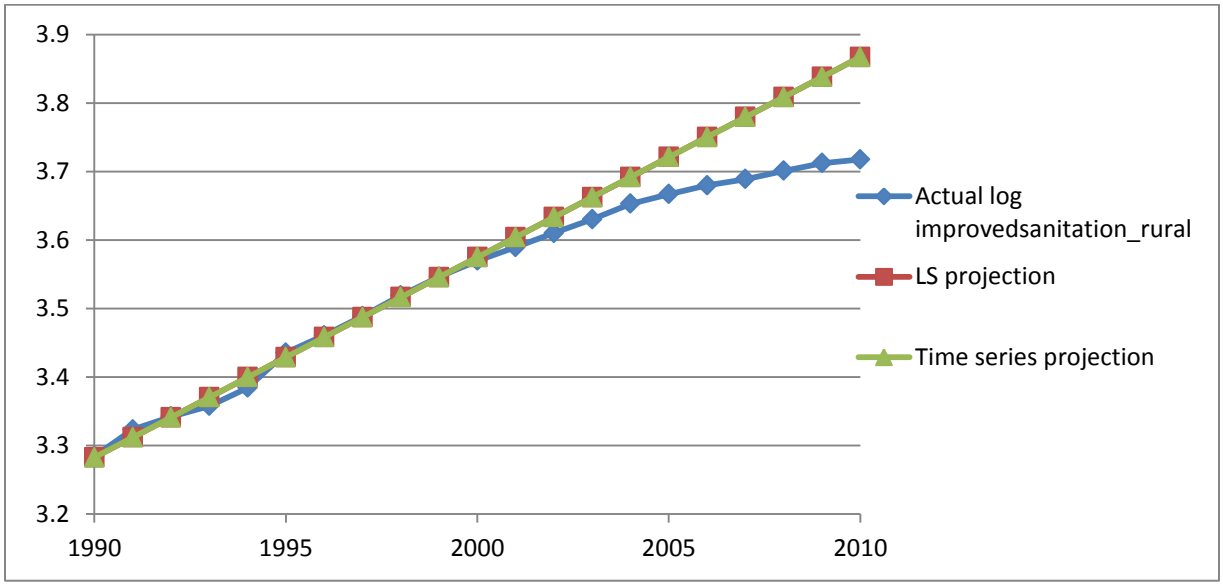
Transformed data:

The transformed data suggests a minor jump (interrupted intercept) in 1995 for the IDA only dataset slope change starting around 1994/1995.



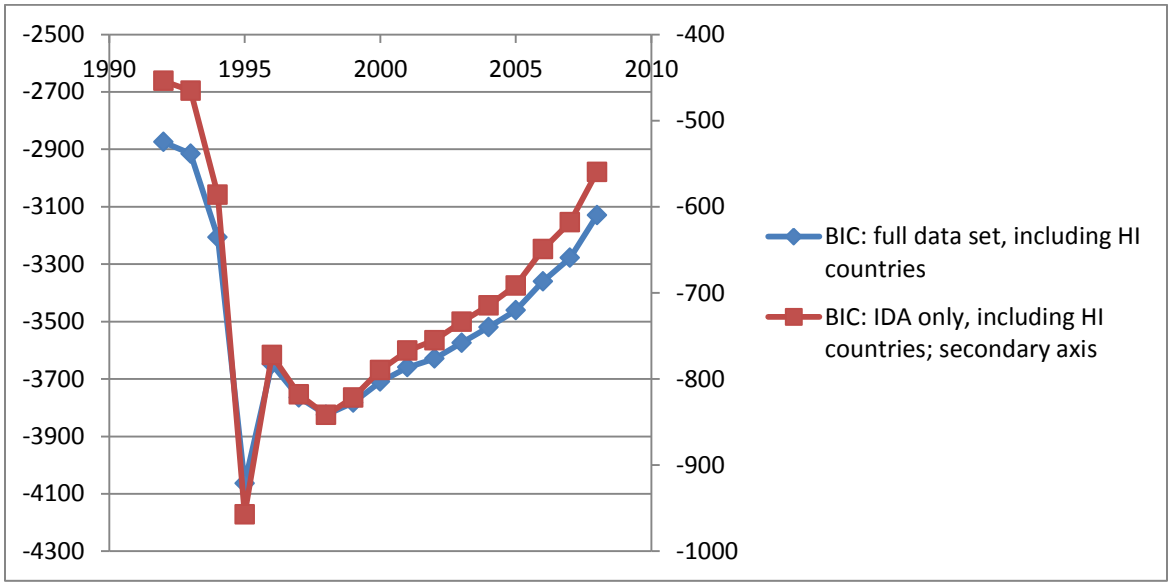
Transformed data: Comparison to least squares regression

The comparison of the actual data to the least square projection shows a clear deviation from the 1990-1999 pace by 2002 with some deceleration in the actual data versus the 1990-1999 pace. Note that the time series fit for this data was a trend, equivalent to linear regression.



BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.

The BIC curve displays a clear minimum at 1995 for both curves though the shape of the curves themselves is somewhat atypical compared to other BIC curves, suggesting the heavy influence of a few countries.



<u>Estimated coefficients from linear mixed model for optimal year.</u>

IDA, IBRD, Blend countries:

Year: 1995

β_2 (interrupted intercept): 0.05225 (p=0.0386)

β_3 (interrupted slope): -0.00435 (p=0.3685)

IDA only countries:

Year: 1995

β_2 (interrupted intercept): 0.09961 (p=0.0948)

β_3 (interrupted slope): -0.00419 (p=0.708)

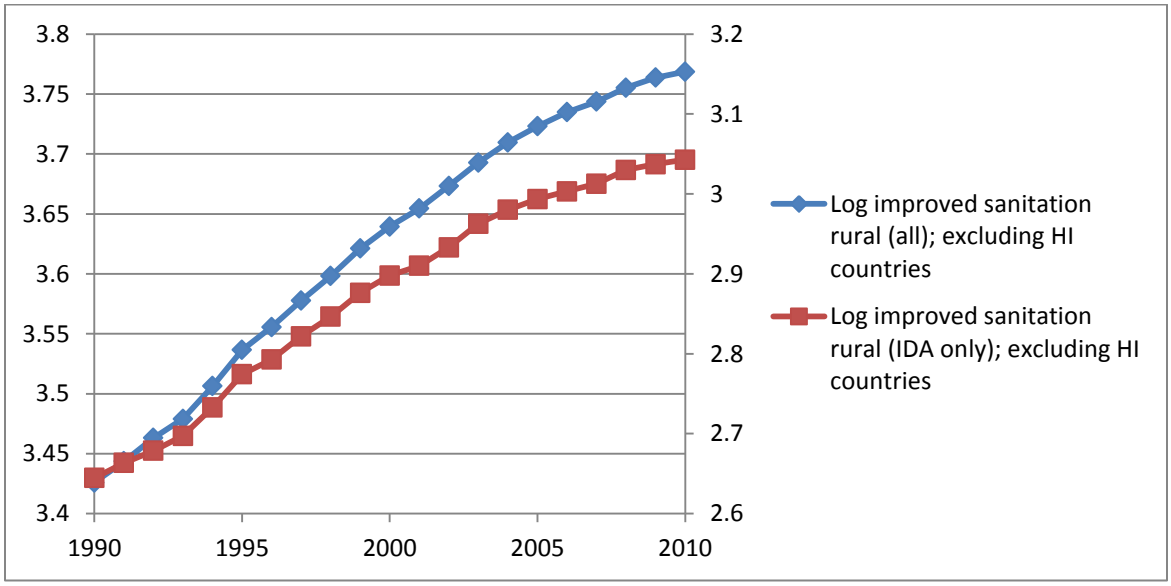
<u>Heavy Influence Countries Identified:</u>

IDA, IBRD, Blend: Benin, Eritrea, Ethiopia

IDA Only: Benin, Eritrea, Ethiopia

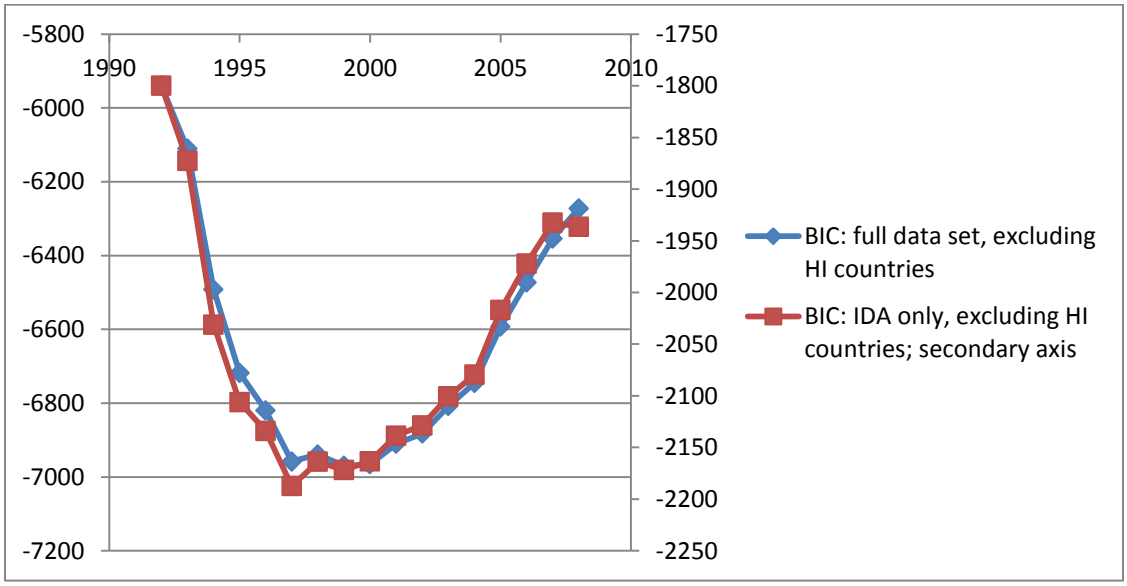
Transformed data (heavy influence countries removed):

After removing the heavy influence countries the datasets continue to appear rather linear with a slight deceleration in both curves starting around 2000.



BIC as a function of interrupted year: Log transformed removing heavy influence countries

The BIC curves both show minimums in the time range from 1997 to 2000 though the actual minimum itself is not as sharp as in other curves. The curves are vastly different from the curves that included the three heavy influence countries.



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

The regression results show a significant deceleration in the rate of improved sanitation for IDA, IBRD and Blend countries starting around 1999 despite the level not being near universal coverage. The coefficients for the IDA only dataset were not statistically significant.

IDA, IBRD, Blend countries:

Year: 1999

β_2 (interrupted intercept): 0.01027 (p=0.0099)

β_3 (interrupted slope): -0.00846 (p<0.0001)

IDA only countries:

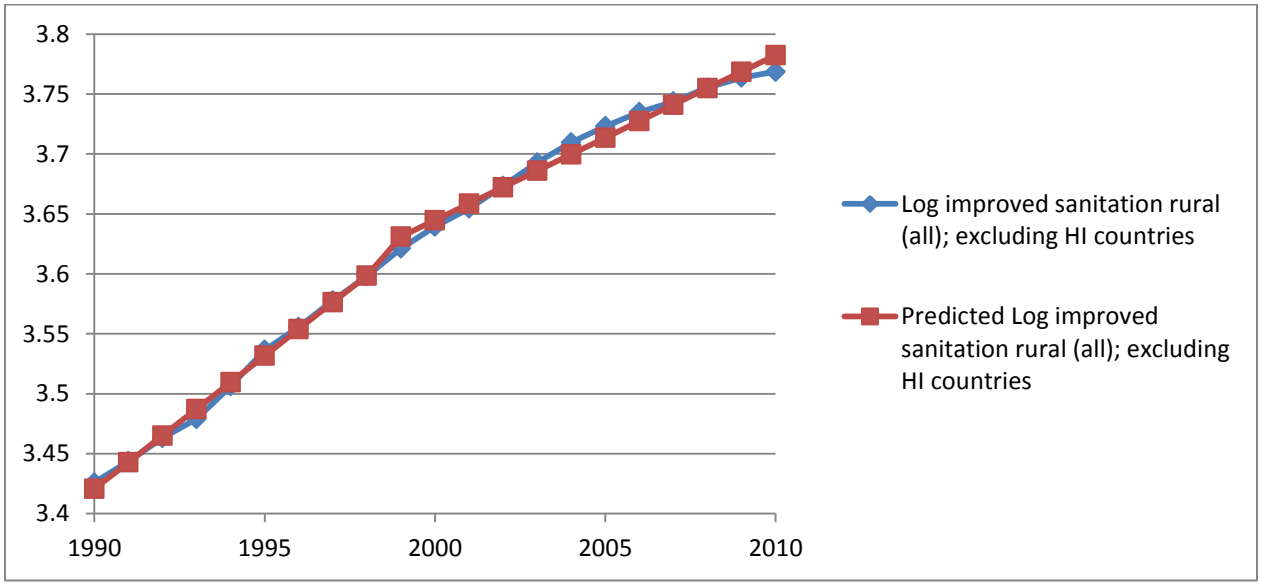
Year: 1997

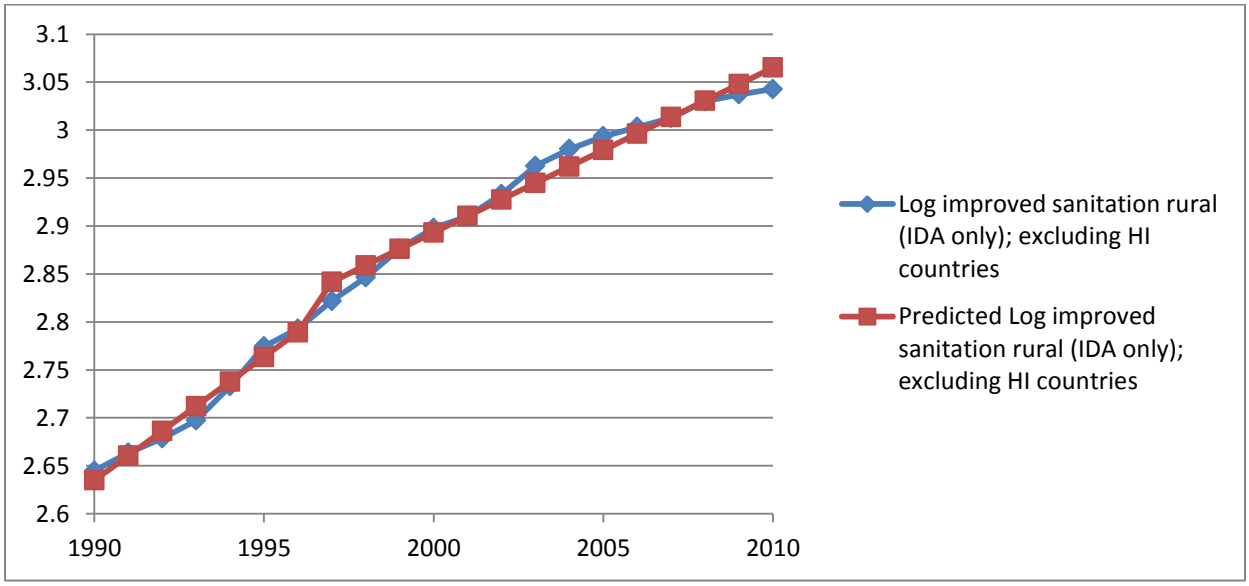
β_2 (interrupted intercept): 0.02667 (p=0.0606)

β_3 (interrupted slope): -0.00854 (p=0.0701)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

Overall the data was well fit by the model for both dataset with the absolute percent deviation less than 1% for all data points.





Adding Non-Linear Fixed Effect:

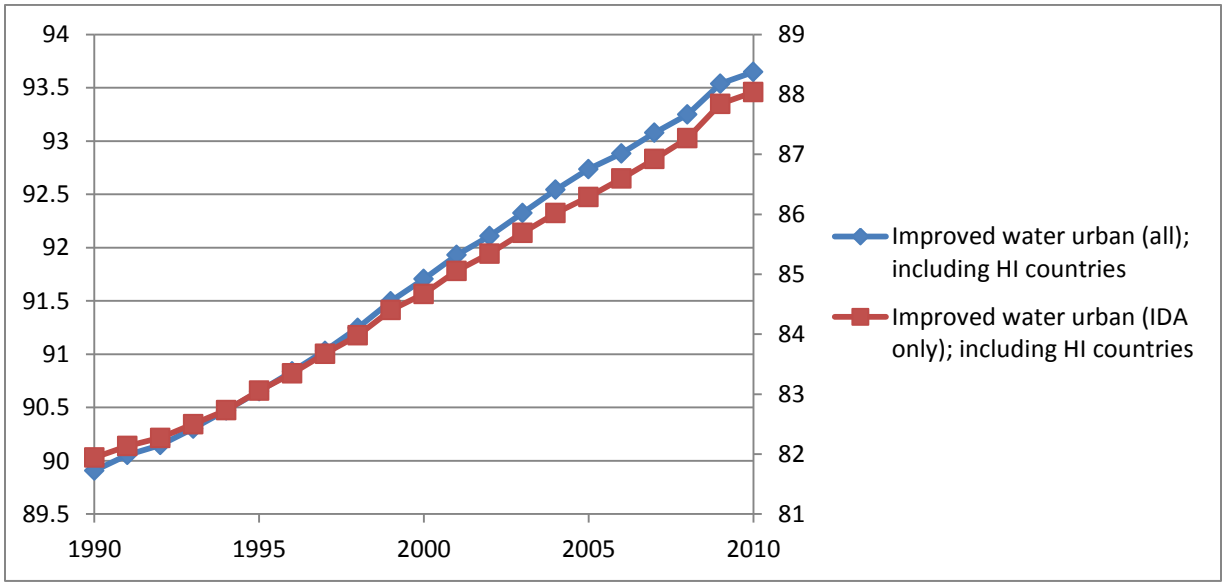
When the fixed effect of year^2 was introduced to the IDA, IBRD and Blend dataset model, the interrupted slope was no longer significant (since the curvature of the data was now captured by the non-linear term). There was no change in the conclusions for the IDA only dataset.

Target 7C Indicator Improved water (urban)

Conclusion: There was a deceleration in the IDA, IBRD and Blend dataset starting around 2001 but not change in the IDA only dataset.

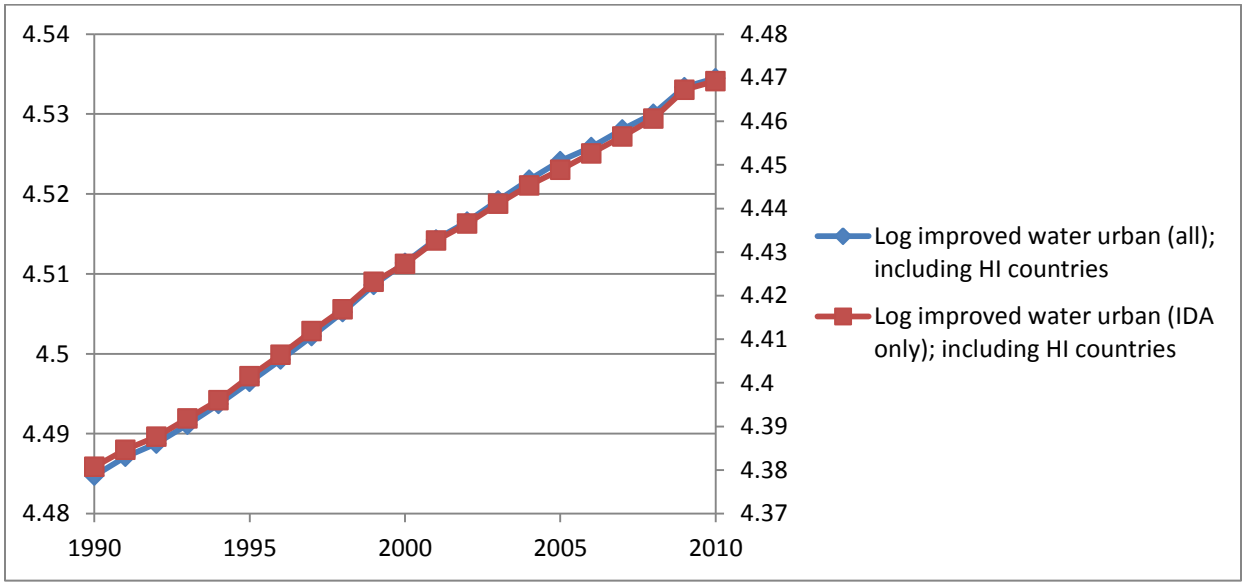
Non-transformed data:

The non-transformed data displays relatively linear curves for both datasets.



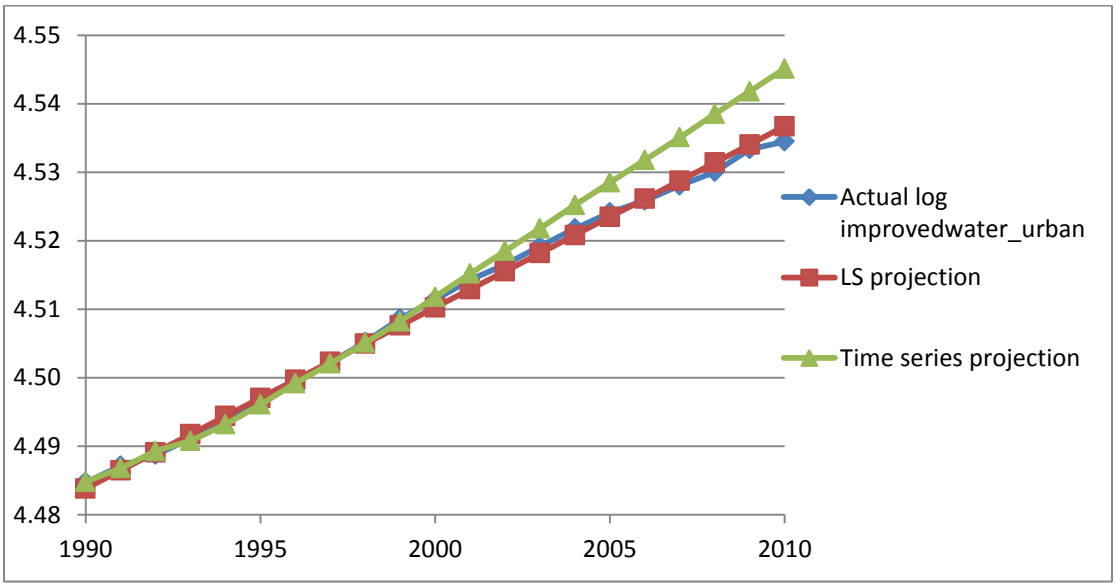
Transformed data:

The transformed data is also fairly linear with no obvious changepoints.



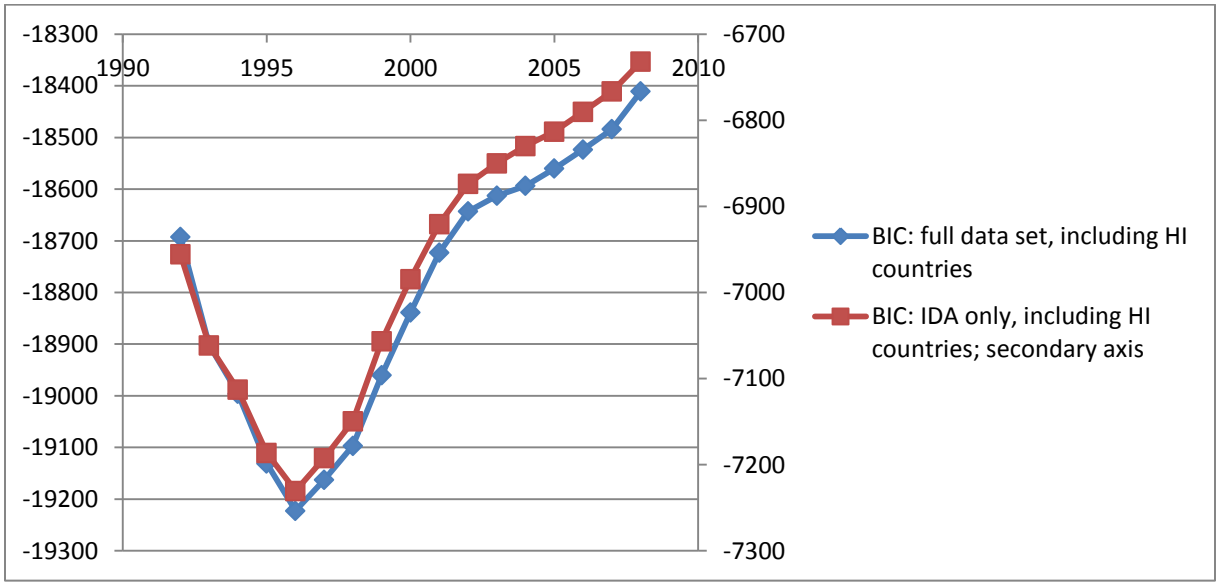
Transformed data: Comparison to least squares regression

The comparison of the IDA, IBRD, and the Blend dataset and time series and least squares projections shows that the time series was very linear with little deviation from the 1990-1999 trend.



BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.

The BIC curve shows clear minimum around 1995 for both datasets.



Estimated coefficients from linear mixed model for optimal year.

IDA, IBRD, Blend countries:

Year: 1996

β_2 (interrupted intercept): 0.00257 (p=0.009)

β_3 (interrupted slope): 0.000138 (p=0.6967)

IDA only countries:

Year: 1996

β_2 (interrupted intercept): 0.004515 (p=0.0304)

β_3 (interrupted slope): 0.000265 (p=0.7354)

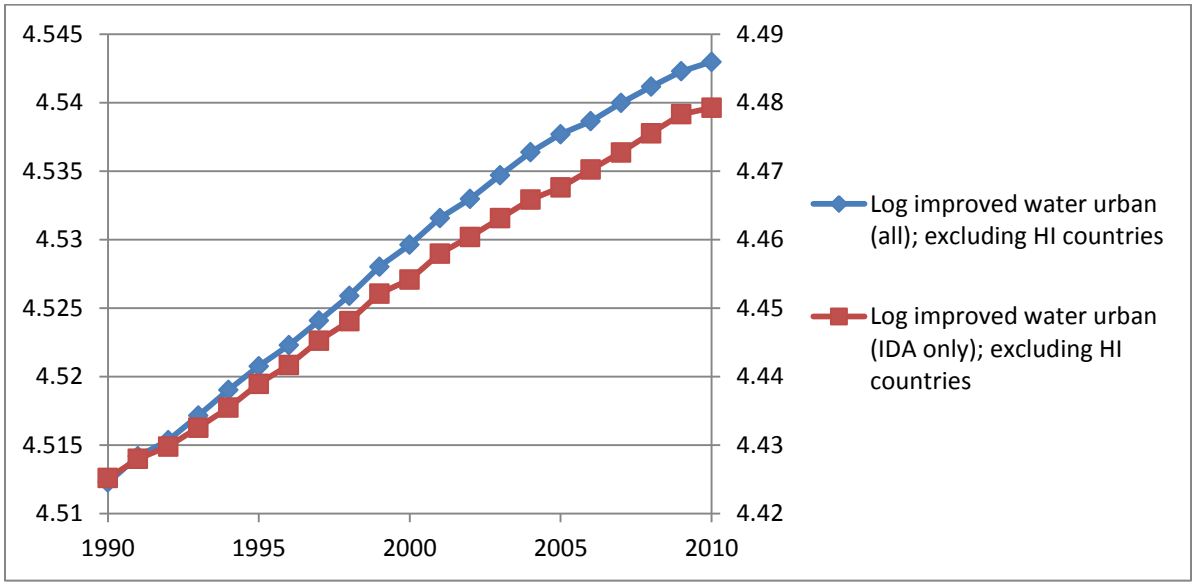
Heavy Influence Countries Identified:

IDA, IBRD, Blend: Angola, Cambodia, Eritrea, Guinea-Bissau, Mauritania, Mongolia

IDA Only: Cambodia, Eritrea, Guinea-Bissau, Mauritania

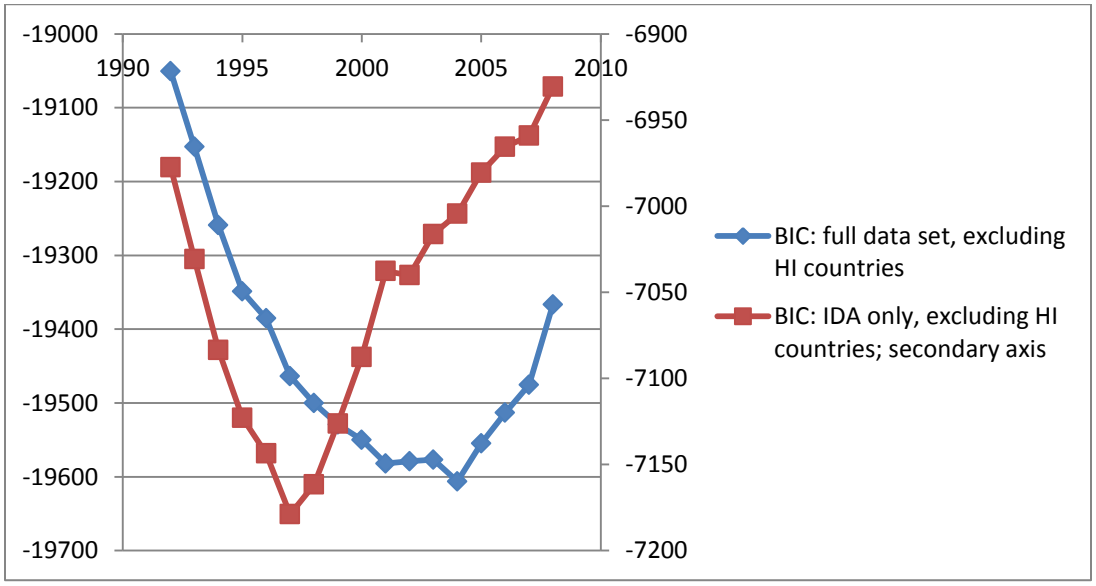
Transformed data (heavy influence countries removed):

After removing the heavy influence countries, the transformed data suggests some deceleration before 2000 for the IDA only curve and some deceleration after 2000 for the IDA, IBRD and Blend curve.



BIC as a function of interrupted year: Log transformed removing heavy influence countries

The BIC curves both shows a clear minimum in 1997 for the IDA only dataset while the IDA, IBRD and Blend dataset minimum is less sharp (between 2001 to 2004).



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

The regression results show a significant interrupted slope in the IDA, IBRD and Blend dataset around 2001.

IDA, IBRD, Blend countries:

Year: 2001

β_2 (interrupted intercept): 0.000855 (p= 0.0566)

β_3 (interrupted slope): -0.00045 (p=0.0019)

IDA only countries:

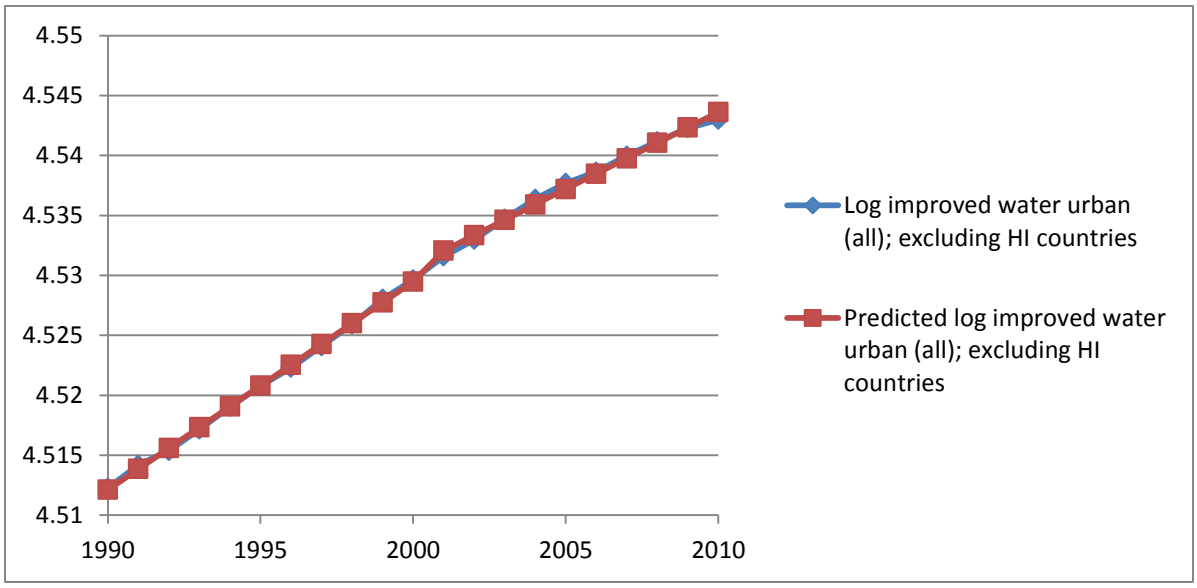
Year: 1997

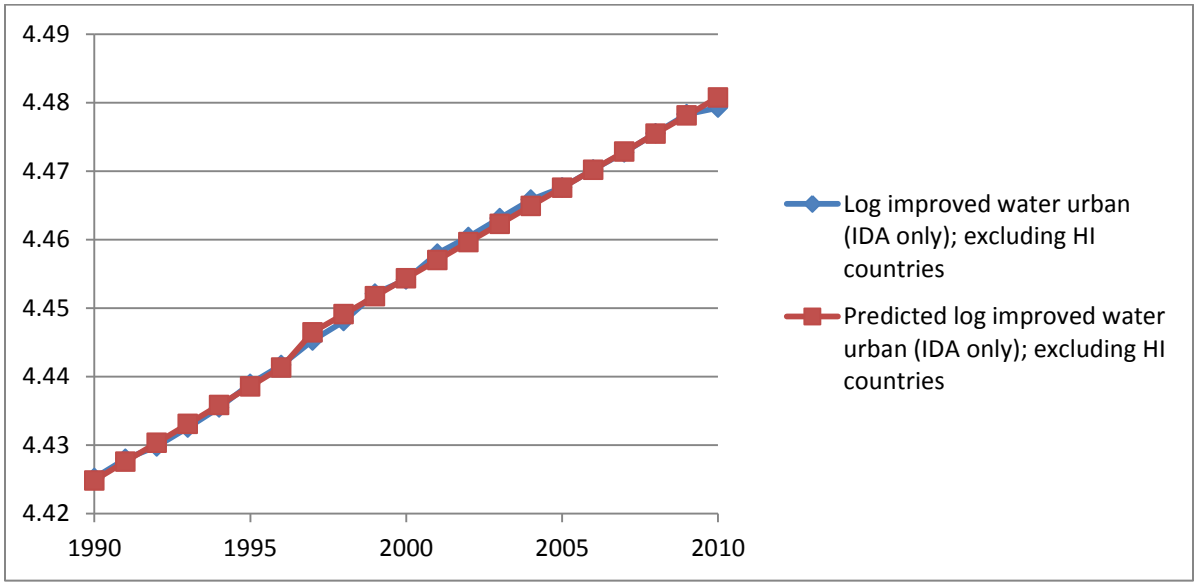
β_2 (interrupted intercept): 0.002374 (p= 0.0368)

β_3 (interrupted slope): -0.00011 (p=0.7834)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

Overall the data was well fit by the model for both dataset with the absolute percent deviation less than 0.1% for all data points.





Adding Non-Linear Fixed Effect:

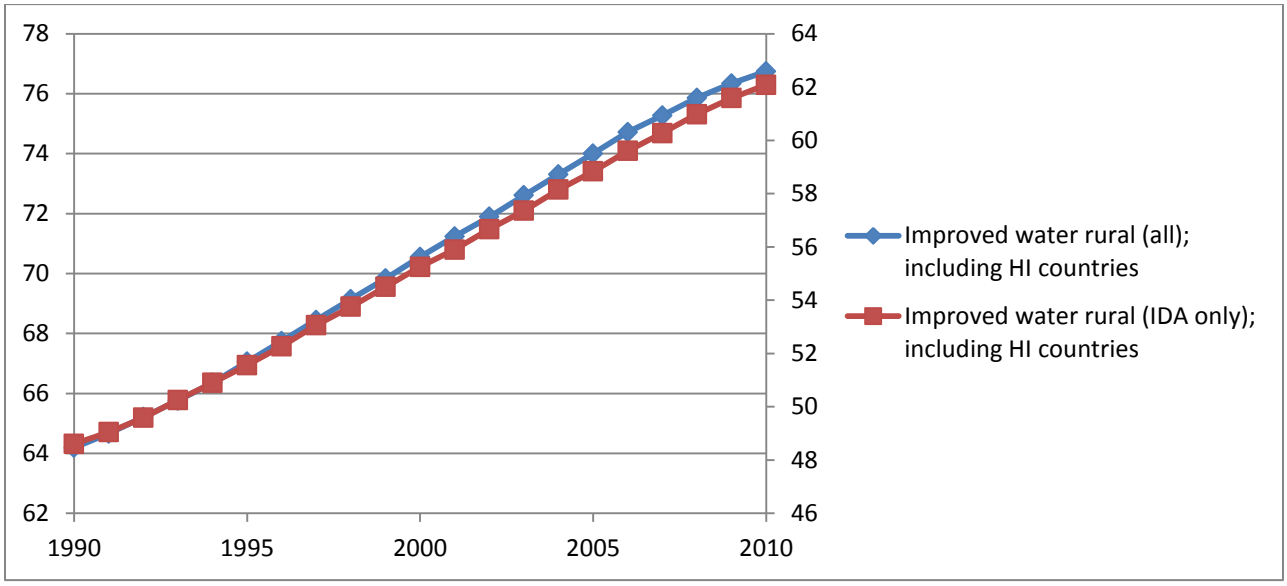
The conclusions were not impacted by the introduction of the fixed effect of year^2 into the models.

Target 7C Indicator Improved water (rural)

Conclusion: There was a significant deceleration in the improved water (rural) in the IDA, IBRD and Blend dataset starting around 1997. The IDA only dataset had no significant changepoints.

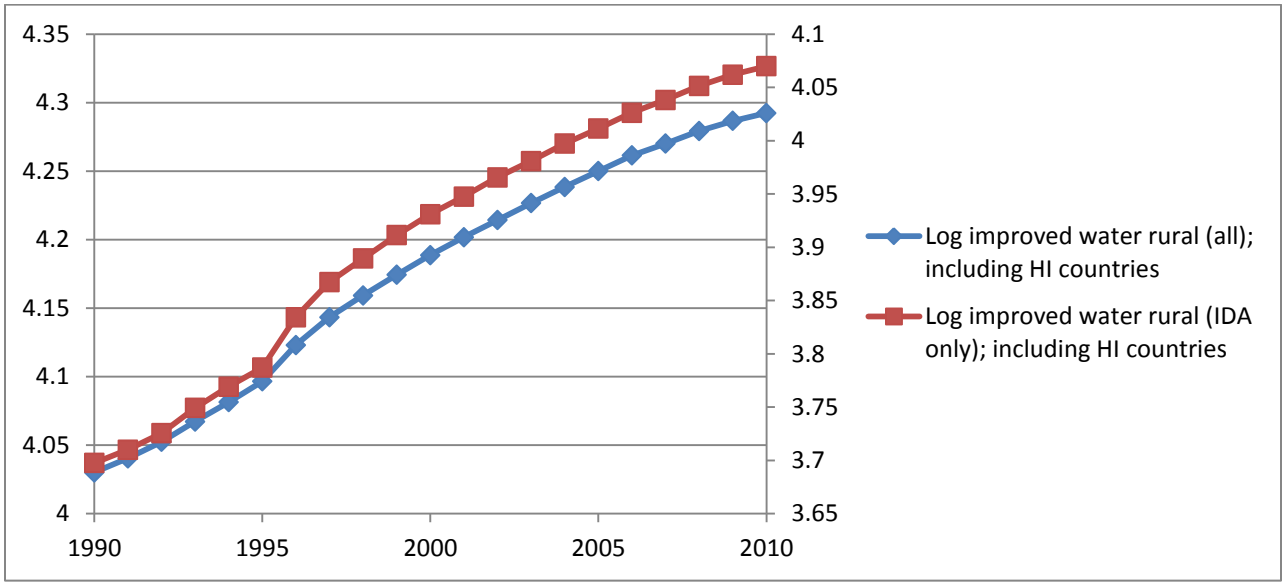
Non-transformed data:

The non-transformed data displays relatively linear curves for both datasets with some deceleration after 2000.



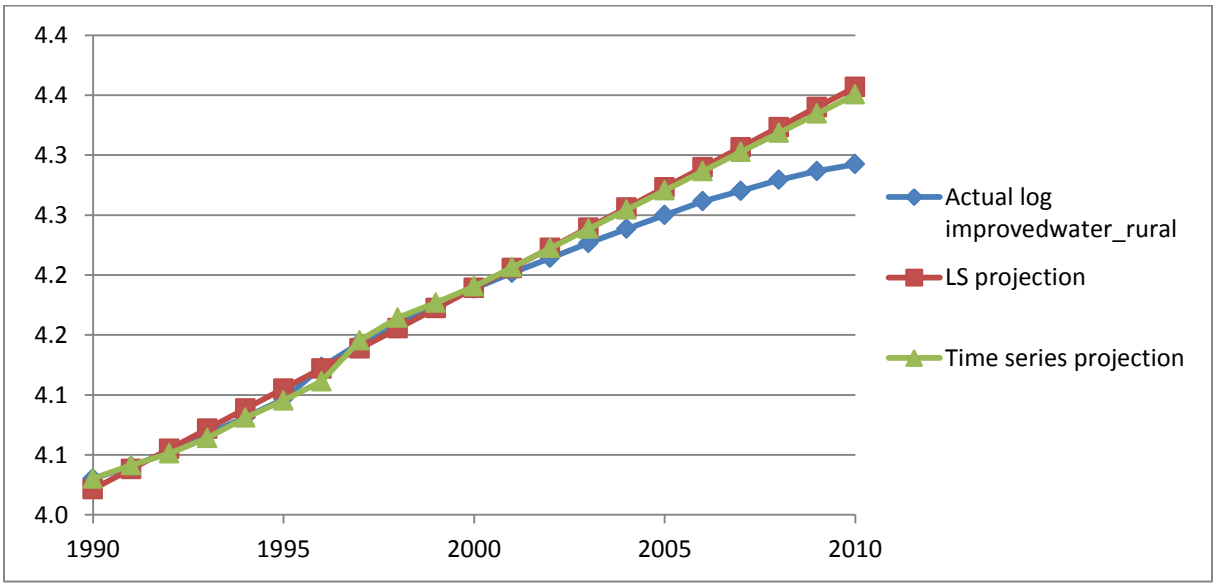
Transformed data:

The transformed data shows a possible step increase (interrupted intercept) around 1995 for both datasets.



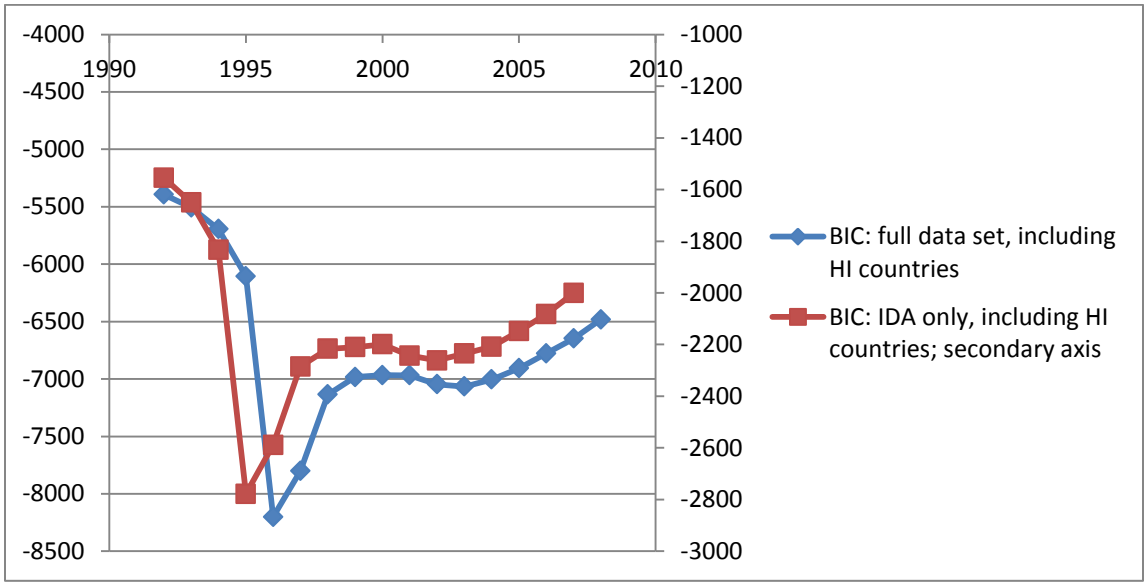
Transformed data: Comparison to least squares regression

The comparison of the IDA, IBRD, and the Blend dataset and time series and least squares projections shows that the dataset deviated noticeably from a linear trend around 2004.



BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.

The BIC curves show clear minimums in 1995 (IDA only) and 1996 (IDA, IBRD and Blend) though the shape of the BIC curves suggests the impact of some heavy influence countries since the curves are not symmetric near the minimums.



Estimated coefficients from linear mixed model for optimal year.

IDA, IBRD, Blend countries:

Year: 1996

β_2 (interrupted intercept): 0.02816 (p= 0.1345)

β_3 (interrupted slope): -0.00139 (p=0.4251)

IDA only countries:

Year: 1996

β_2 (interrupted intercept): 0.05327 (p= 0.2233)

β_3 (interrupted slope): -0.00216 (p=0.5723)

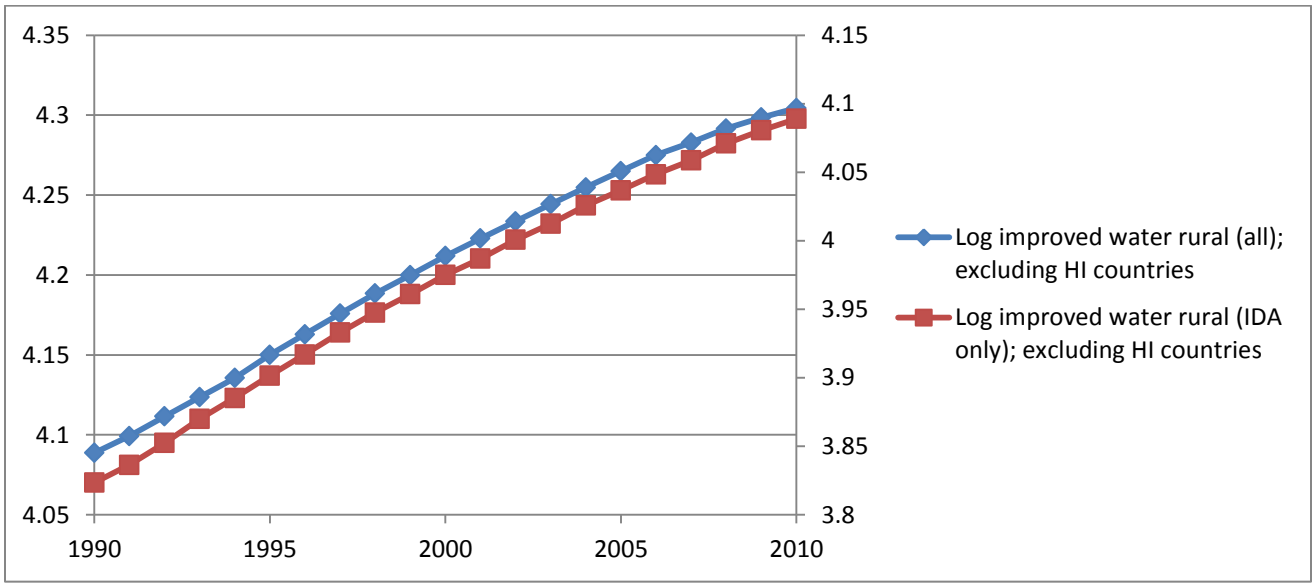
Heavy Influence Countries Identified:

IDA, IBRD, Blend: Afghanistan, Ethiopia

IDA Only: Afghanistan, Ethiopia

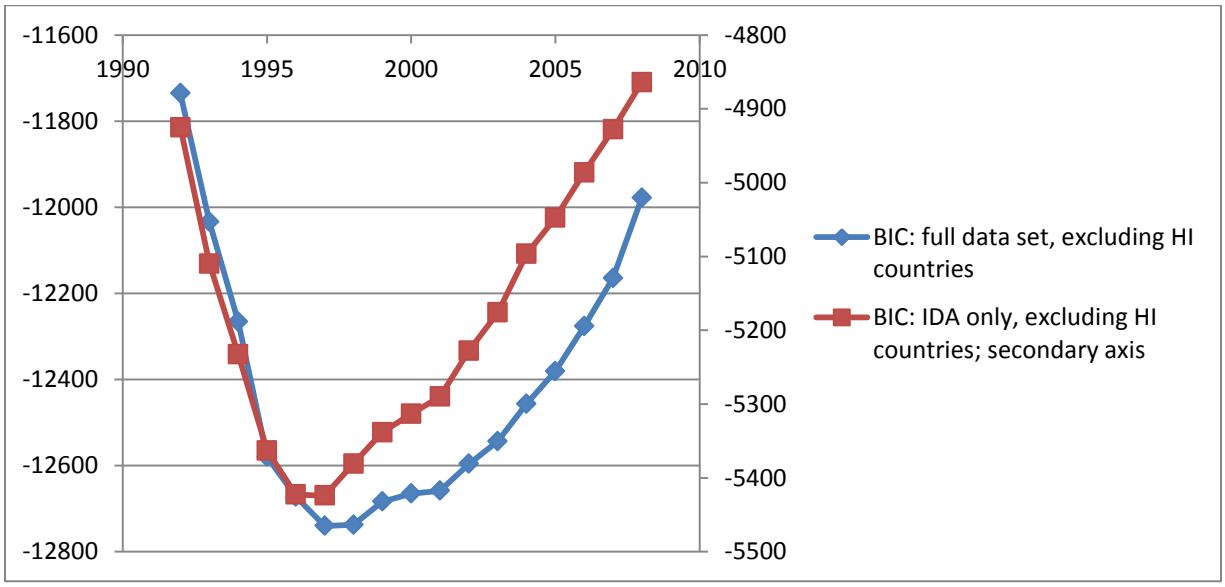
Transformed data (heavy influence countries removed):

After removing the heavy influence countries, the transformed data is very linear with a slight suggestion of deceleration around 2000 for both curves.



BIC as a function of interrupted year: Log transformed removing heavy influence countries

The BIC curves both shows a clear minimum around 1996/1997 for the IDA only curve while the IDA, IBRD and Blend curve minimum is 1997/1998.



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

The regression results show a significant

IDA, IBRD, Blend countries:

Year: 1997

β_2 (interrupted intercept): 0.006786 (p= 0.0006)

β_3 (interrupted slope): -0.00238 (p=0.0018)

IDA only countries:

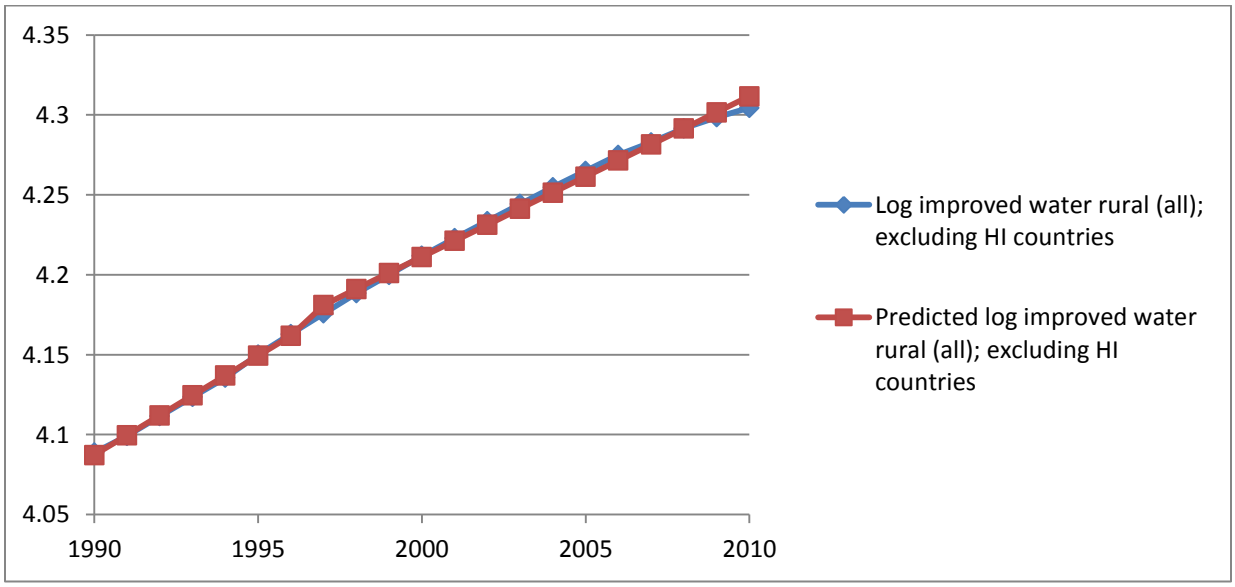
Year: 1997

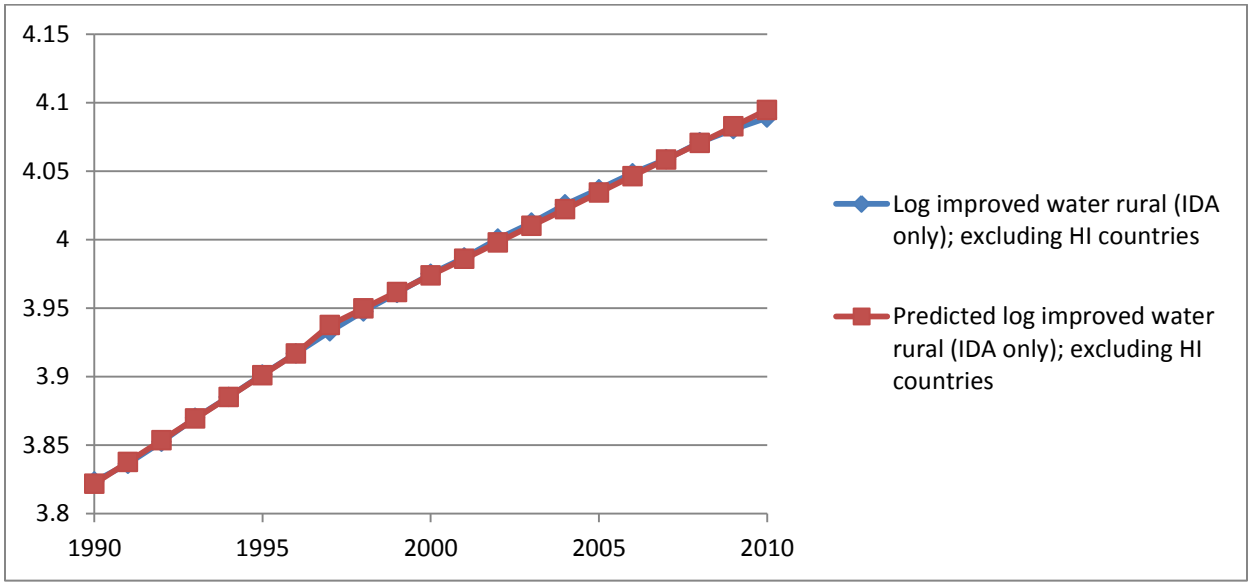
β_2 (interrupted intercept): 0.004851 (p= 0.0855)

β_3 (interrupted slope): -0.00377 (p=0.0017)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

Overall the data was well fit by the model for both dataset with the absolute percent deviation less than 0.2% for all data points.





Adding Non-Linear Fixed Effect:

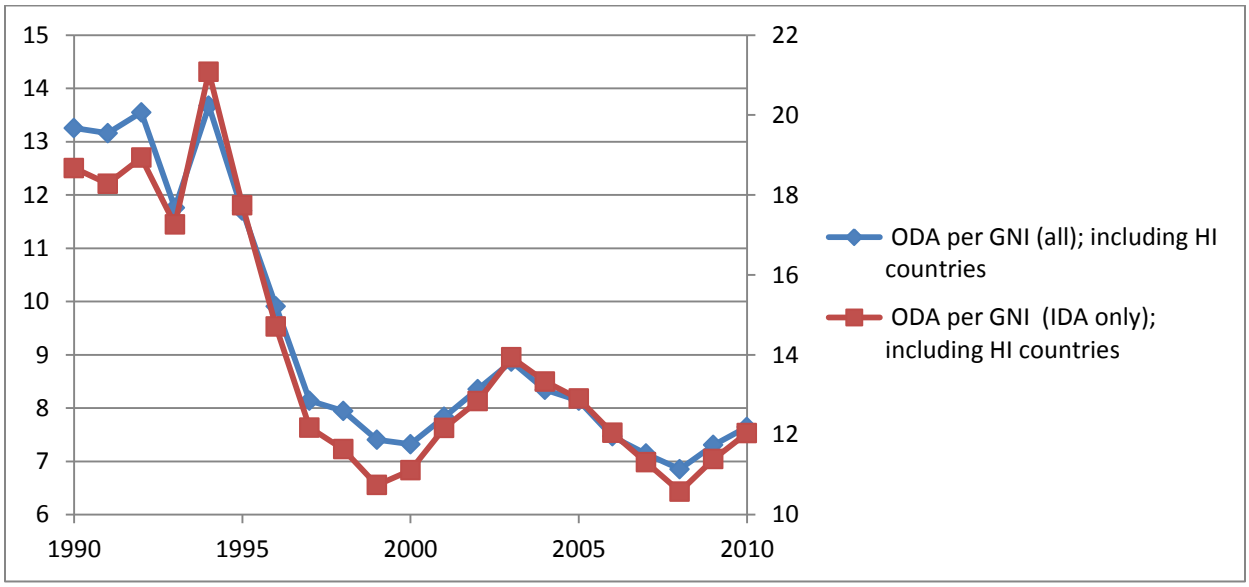
The interrupted slope was in the IDA, IBRD, and Blend dataset model was no longer significant after the introduction of the fixed effect of year^2 into the model. The IDA only model results were unaffected.

Target 8A Indicator Net ODA (% of GNI)

Conclusion: Note: This analysis was performed on the log (net ODA % GNI) so only countries with positive net ODA were included in the analysis. There was a significant deceleration (interrupted intercept) in the IDA only countries starting in 1997.

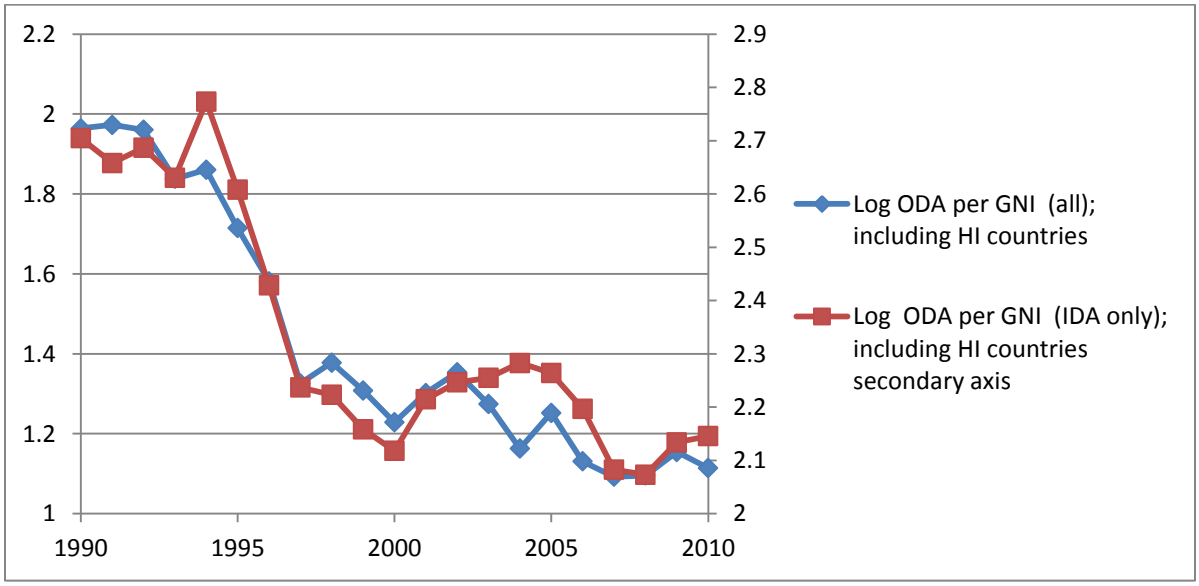
Non-transformed data:

The non-transformed data show that the net ODA per GNI dropped sharply from the mid 1990's to around 2000 and then stabilized for the IDA only as well as the IDA, IBRD and Blend countries. Because this is a ratio, the stabilization period (late 1990's to 2010) are a period where the growth in net ODA was similar to the growth in GNI.



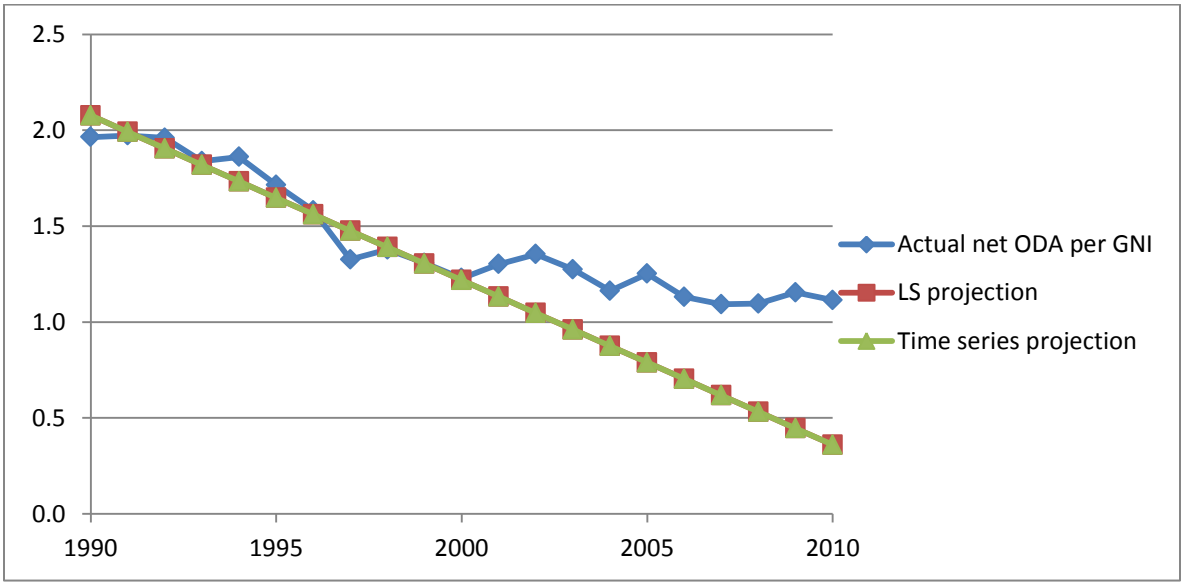
Transformed data:

The transformed data show that the net ODA per GNI dropped sharply from the mid 1990's to around 2000 and then stabilized for the IDA only as well as the IDA, IBRD and Blend countries. Because this is a ratio, the stabilization period (late 1990's to 2010) is a period where the growth in net ODA was similar to the growth in GNI.

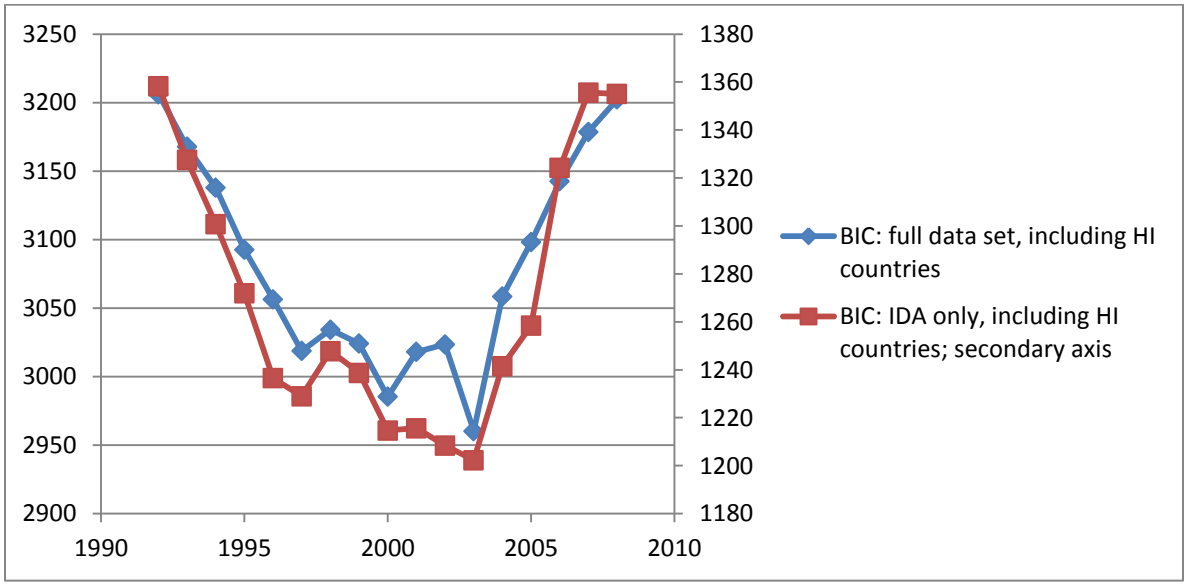


Transformed data: Comparison to least squares regression

The comparison of the IDA, IBRD, and the Blend dataset and time series and least squares projections shows that the dataset deviated noticeably from a linear trend around 2001. Note that the time series projection was a constant trend, equivalent to the least squares projection.



BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.



The BIC curves show minimums in 2003 but also local minimums in 1997 and 2000. The noisy nature of this curve suggests the impact of heavy influence countries.

Estimated coefficients from linear mixed model for optimal year.

IDA, IBRD, Blend countries:

Year: 2003

β_2 (interrupted intercept): 0.1258 (p=0.1291)

β_3 (interrupted slope): 0.05091 (p=0.0035)

IDA only countries:

Year: 2003

β_2 (interrupted intercept): 0.2227 (p=0.0142)

β_3 (interrupted slope): 0.02952 (p=0.1357)

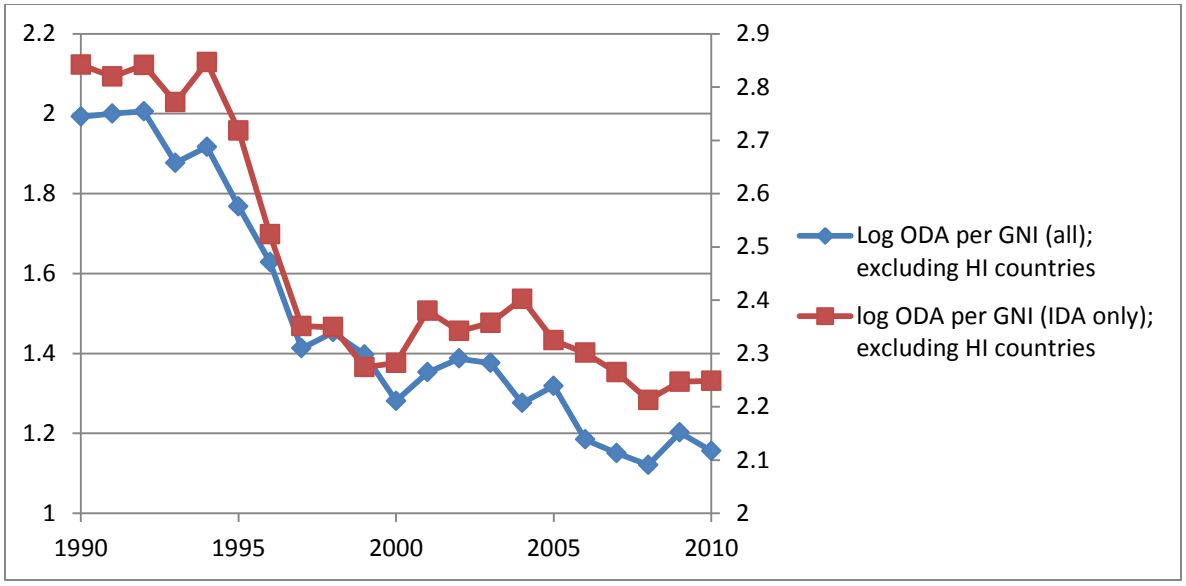
Heavy Influence Countries Identified:

IDA, IBRD, Blend: St. Kitts and Nevis, Turkey

IDA Only: Angola, Congo, Dem. Rep., Congo, Rep., Cote d'Ivoire, Nigeria

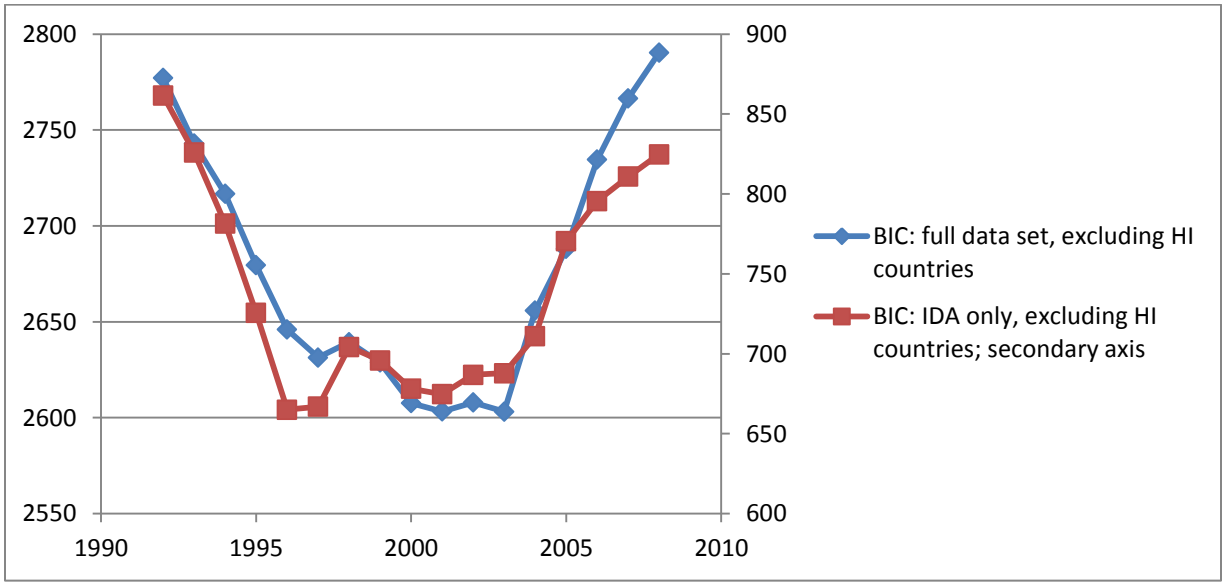
Transformed data (heavy influence countries removed):

After removing the heavy influence countries, the transformed data has the same basic shape with a level period from 1990 to around 1993, a decline from 1993 until the late 1990's then a more stable level from the late 1990's to 2010. Because this is a ratio, the stabilization period (late 1990's to 2010) is a period where the growth in net ODA was similar to the growth in GNI.



BIC as a function of interrupted year: Log transformed removing heavy influence countries

The BIC curves both shows a broad range of years that could be minimums. Neither curve has the typical sharp minimum seen in most of the other datasets.



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

The regression results show a significant interrupted intercept in 1997 for the IDA only countries and no significant shift in the IDA, IBRD and Blend countries.

IDA, IBRD, Blend countries:

Year: 2003

β_2 (interrupted intercept): 0.1574 (p=0.0205)

β_3 (interrupted slope): 0.03846 (p=0.0116)

IDA only countries:

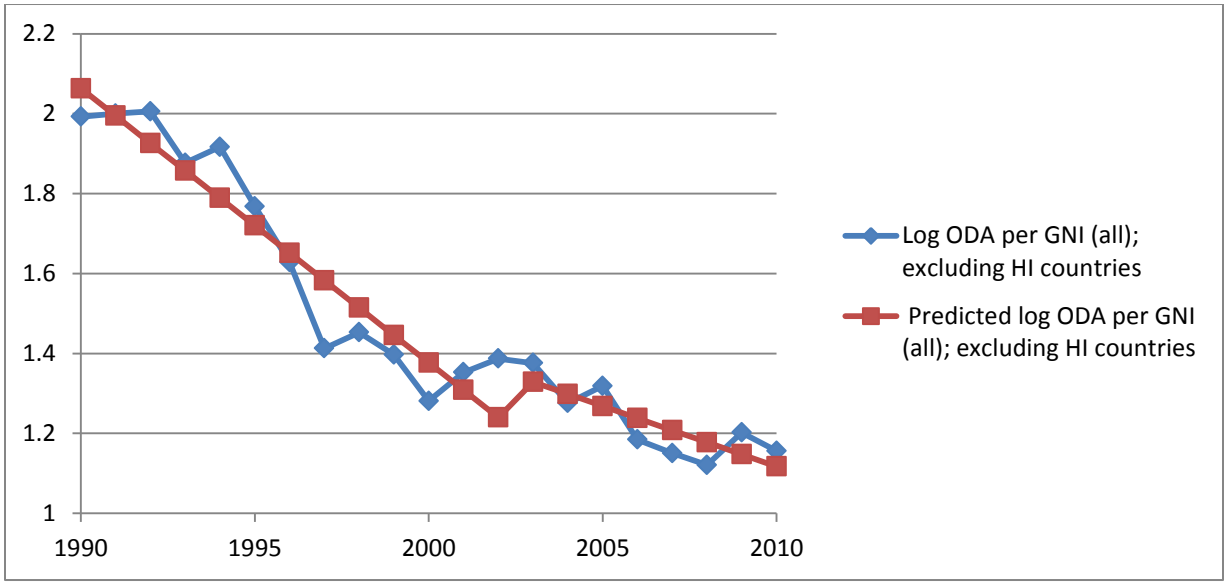
Year: 1997

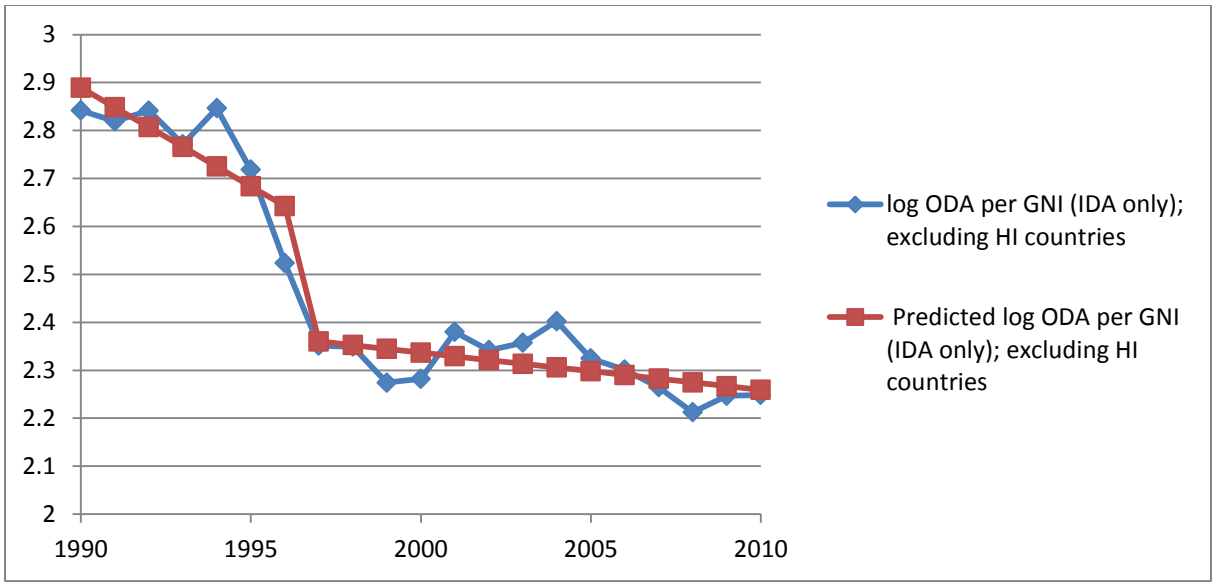
β_2 (interrupted intercept): -0.241 (p=0.0003)

β_3 (interrupted slope): 0.03339 (p=0.0817)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

Overall the data was not as well fit by the models as some of the other datasets. The absolute percent deviation less than 5% for all data points in the IDA only dataset but exceeded 5% for six data points in the IDA, IBRD and Blend dataset. This relatively high absolute percent deviation is related to the data having values close to zero.





Adding Non-Linear Fixed Effect:

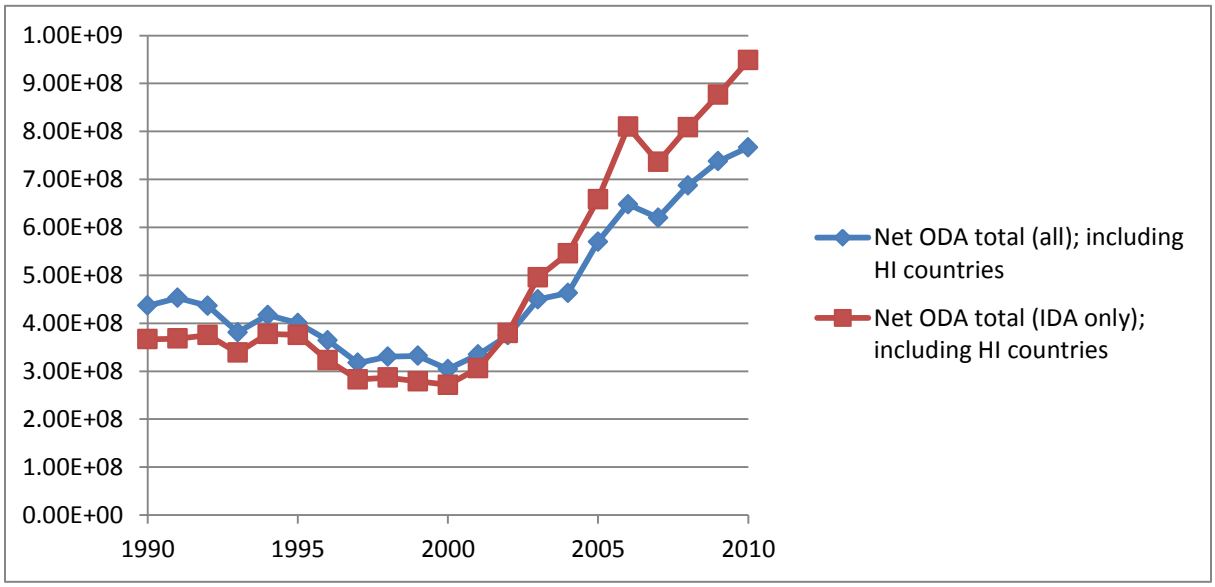
The introduction of the fixed effect of year^2 into the models did not change the conclusions for either the IDA only or the IDA, IBRD and Blend models.

Target 8A Indicator Net ODA received (current US$)

Conclusion: There was a significant acceleration (interrupted slope) in the Net ODA received for the IDA only countries (2002) and the IDA, IBRD and Blend countries (2000) though it is important to note that for the IDA only countries a plausible model could have been produced for the changepoint occurring in 2000, rather than in 20002.

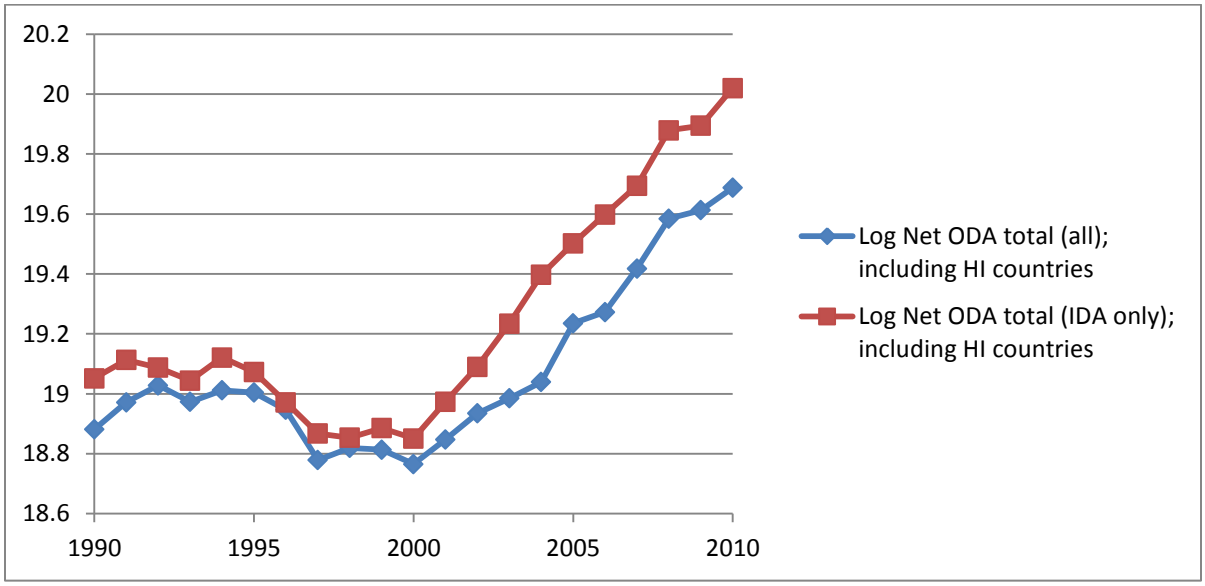
Non-transformed data:

The non-transformed data show that the net ODA was steady in both the IDA only and the IDA, IBRD and Blend countries from 1990 to about 1994 and declined from about 1995 to around 2000. Starting around 2000, the net ODA began increasing annually.



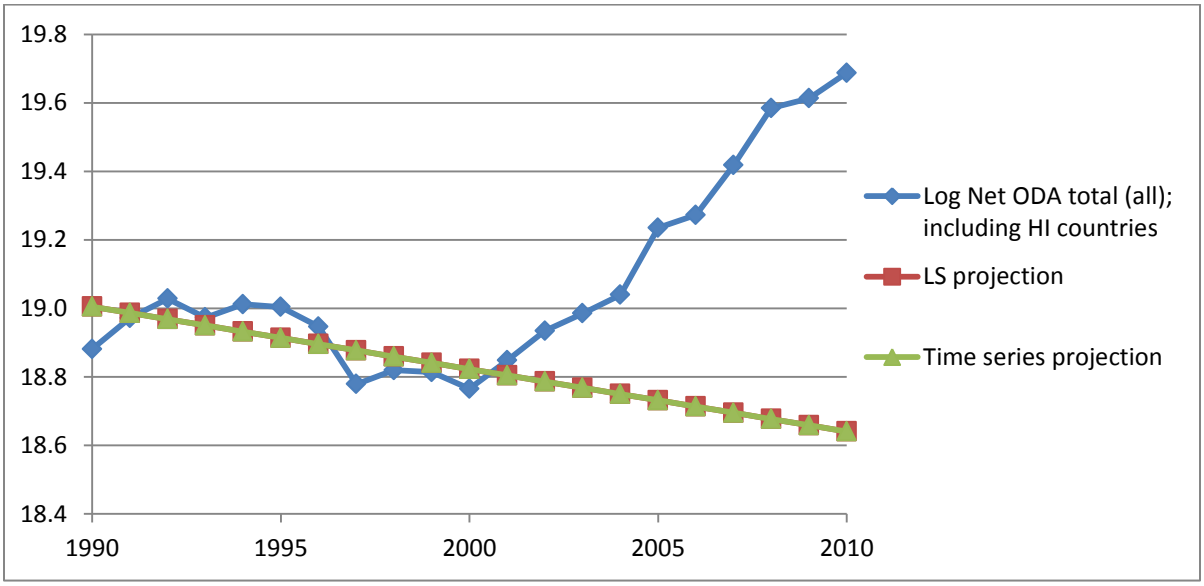
Transformed data:

The transformed data show the same trends and the non-transformed data. The net ODA was steady in both the IDA only and the IDA, IBRD and Blend countries from 1990 to about 1994 and declined from about 1995 to around 2000. Starting around 2000, the net ODA began increasing annually.



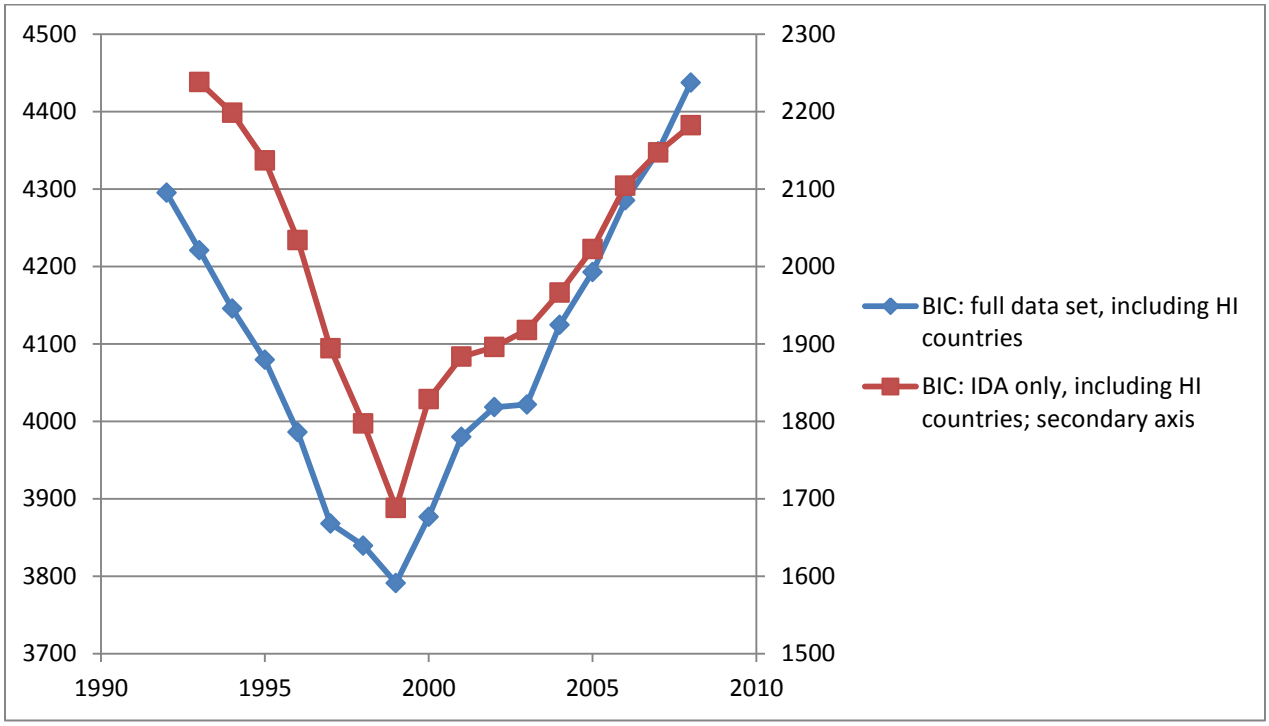
Transformed data: Comparison to least squares regression

The comparison of the IDA, IBRD, and the Blend dataset and time series and least squares projections shows that the dataset deviated noticeably from the declining linear trend of 1990-1999 around 2001. Note that the time series projection was a constant trend, equivalent to the least squares projection.



BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.

The BIC curves show clear minimums in 1999 for both the IDA only and the IDA, IBRD and Blend datasets.



Estimated coefficients from linear mixed model for optimal year.

IDA, IBRD, Blend countries:

Year: 1999

β_2 (interrupted intercept): -0.1695 (p= 0.0657)

β_3 (interrupted slope): 0.1064 (p<0.0001)

IDA only countries:

Year: 1999

β_2 (interrupted intercept): -0.08152 (p= 0.5294)

β_3 (interrupted slope): 0.1423 (p<0.0001)

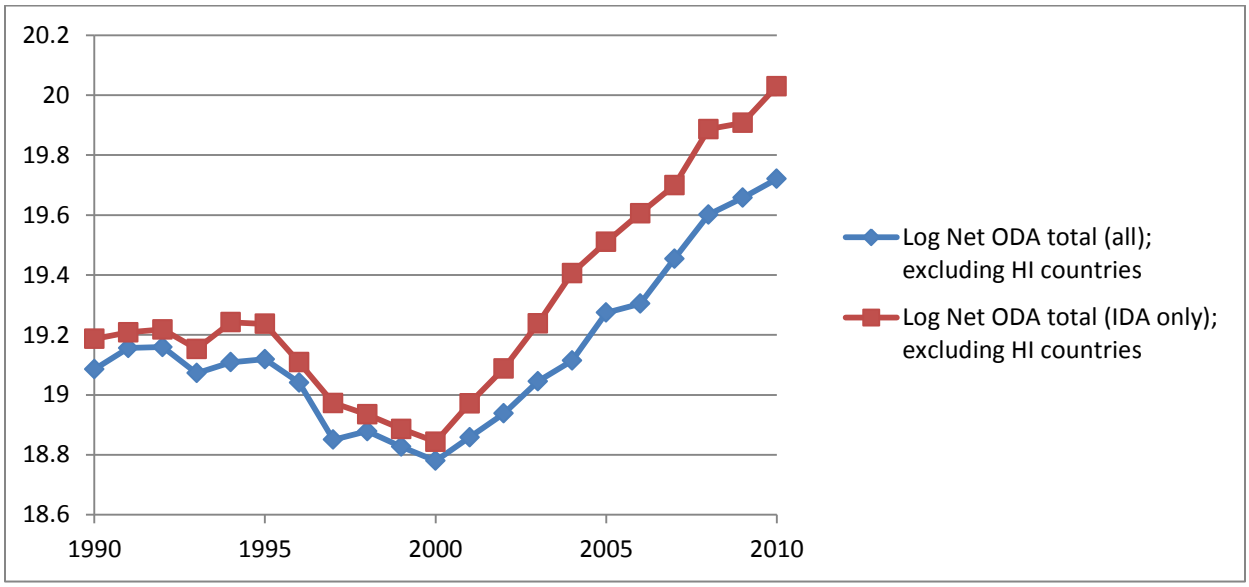
Heavy Influence Countries Identified:

IDA, IBRD, Blend: Bosnia and Herzegovina, St. Kitts and Nevis, Timor-Leste

IDA Only: Timor-Leste

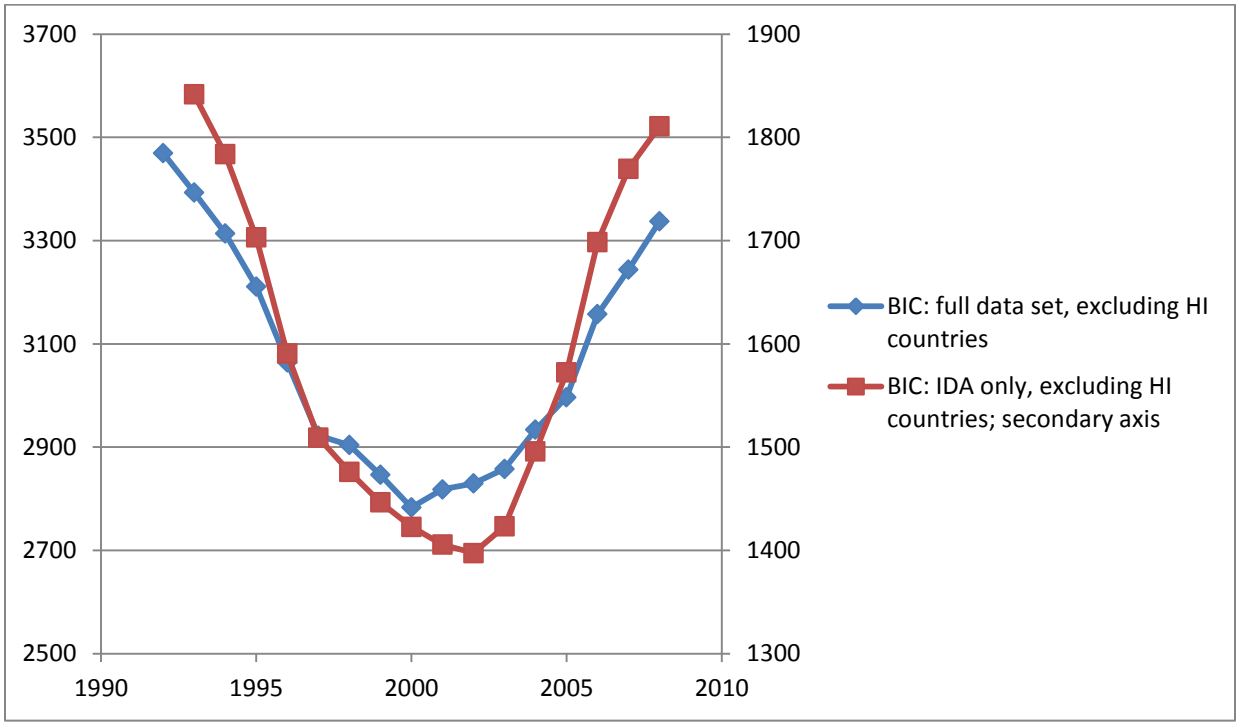
Transformed data (heavy influence countries removed):

After removing the heavy influence countries, the transformed data has the same basic shape with a level period from 1990 to around 1994, a declining period (1995 to 2000) and after 2000 when the ODA grew steadily in both curves.



BIC as a function of interrupted year: Log transformed removing heavy influence countries

The BIC curves with the heavy influence countries removed show a broader pattern with a minimum in 2000 for the IDA, IBRD and Blend countries and a minimum in 2002 for the IDA only countries.



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

The regression results show a significant interrupted intercept in 1997 for the IDA only countries and no significant shift in the IDA, IBRD and Blend countries.

IDA, IBRD, Blend countries:

Year: 2000

β_2 (interrupted intercept): -0.07852 (p=0.2045)

β_3 (interrupted slope): 0.1348 (p<0.0001)

IDA only countries:

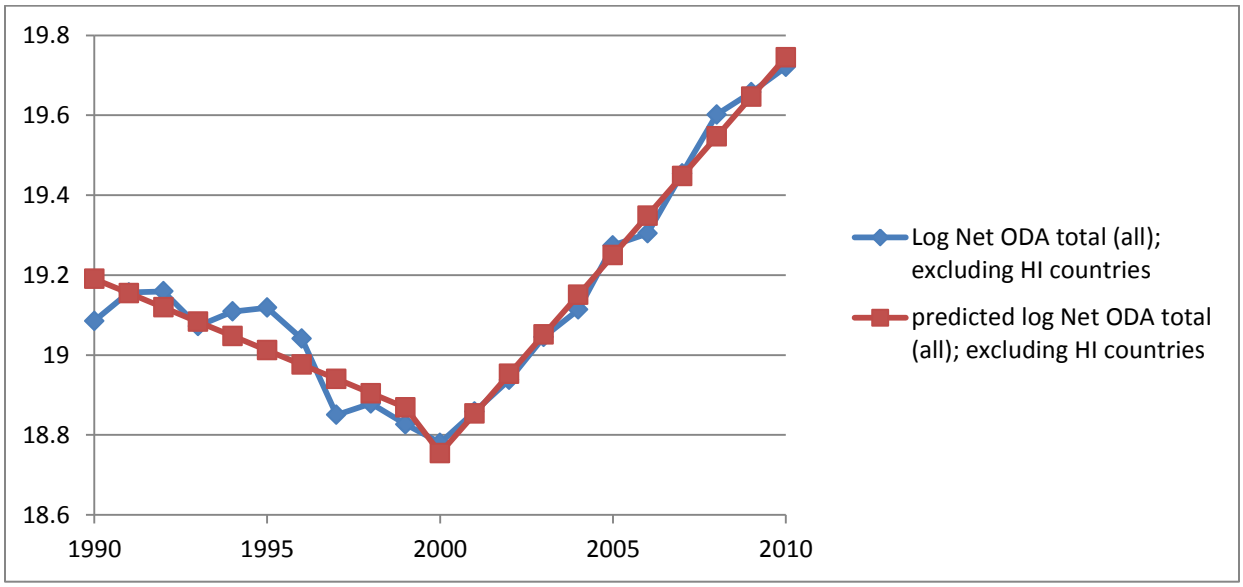
Year: 2002

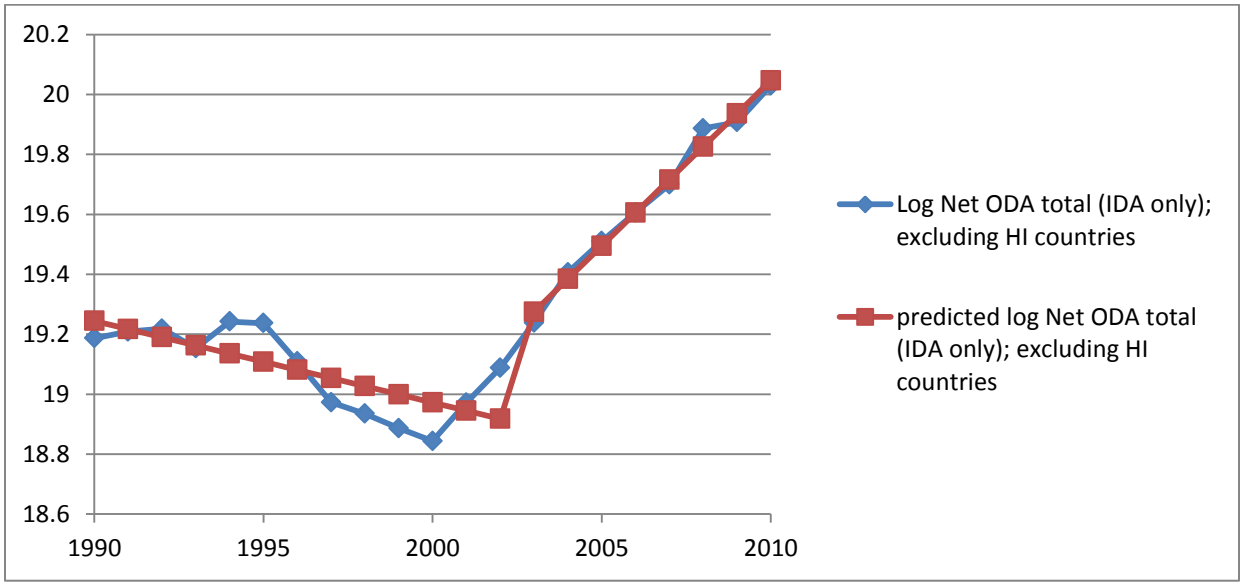
β_2 (interrupted intercept): 0.2823 (p=0.0005)

β_3 (interrupted slope): 0.1504 (p<0.0001)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

Overall the data was well fit by the model with an absolute percent deviation of less than 1% for all data points for both models. The model for the IDA only curve would also have a significant interrupted slope if the interruption was in 2000, rather than the 20002 that was identified in the BIC analysis.





Adding Non-Linear Fixed Effect:

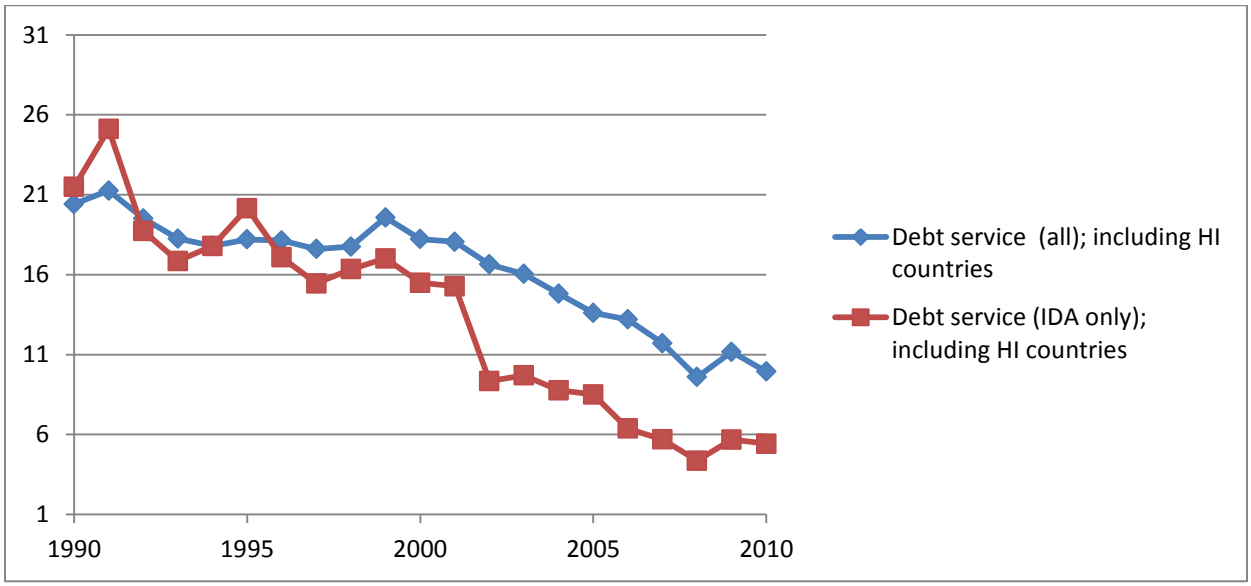
The introduction of the fixed effect of year^2 into the models did not change the conclusions for either the IDA only or the IDA, IBRD and Blend models.

Target 8D Indicator Total Debt Service

Conclusion: Both the IDA, IBRD and Blend dataset (2002) and the IDA only dataset (2007) experienced accelerated reductions in debt service after 2000.

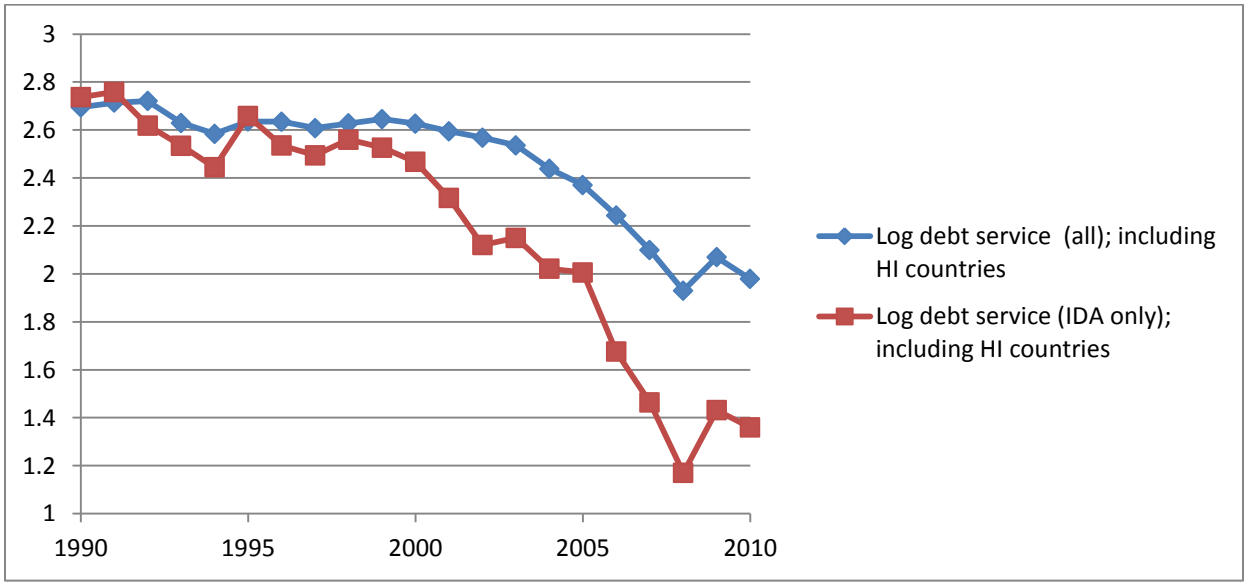
Non-transformed data:

The non-transformed data show that the total debt service had a step drop in 2002 for the IDA only population while the IDA, IBRD and Blend countries appeared to have a slope change around 2000.



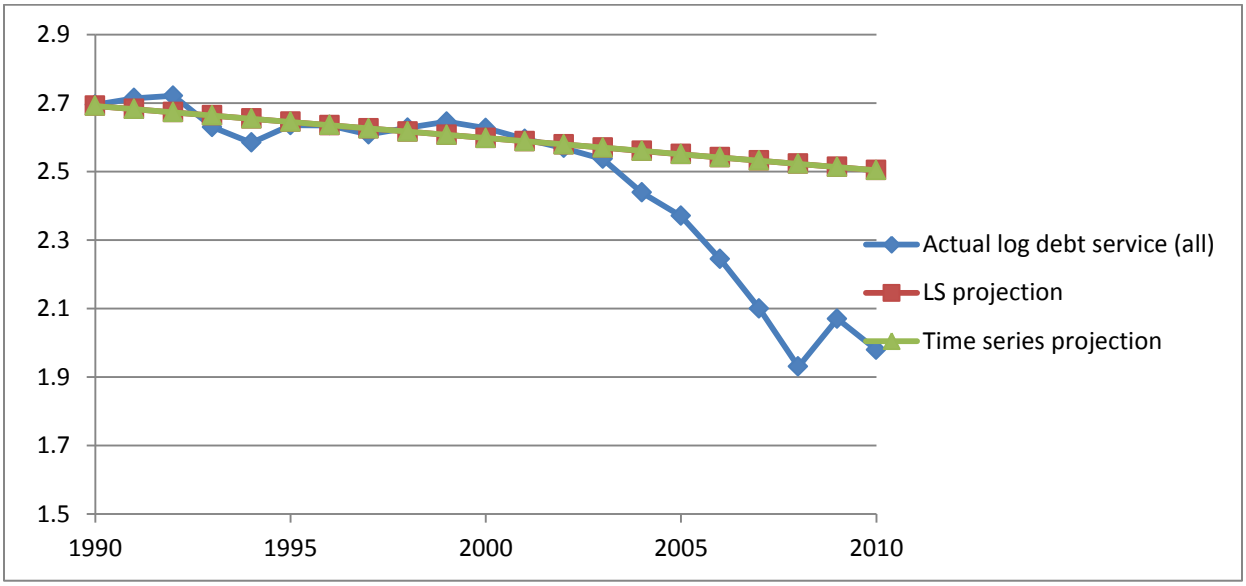
Transformed data:

The transformed data show that log debt service have a slope change after 2000 for the IDA, IBRD and Blend countries while there appears to have been a sharp interrupted intercept or interrupted slope change around 2005 for the IDA only dataset.



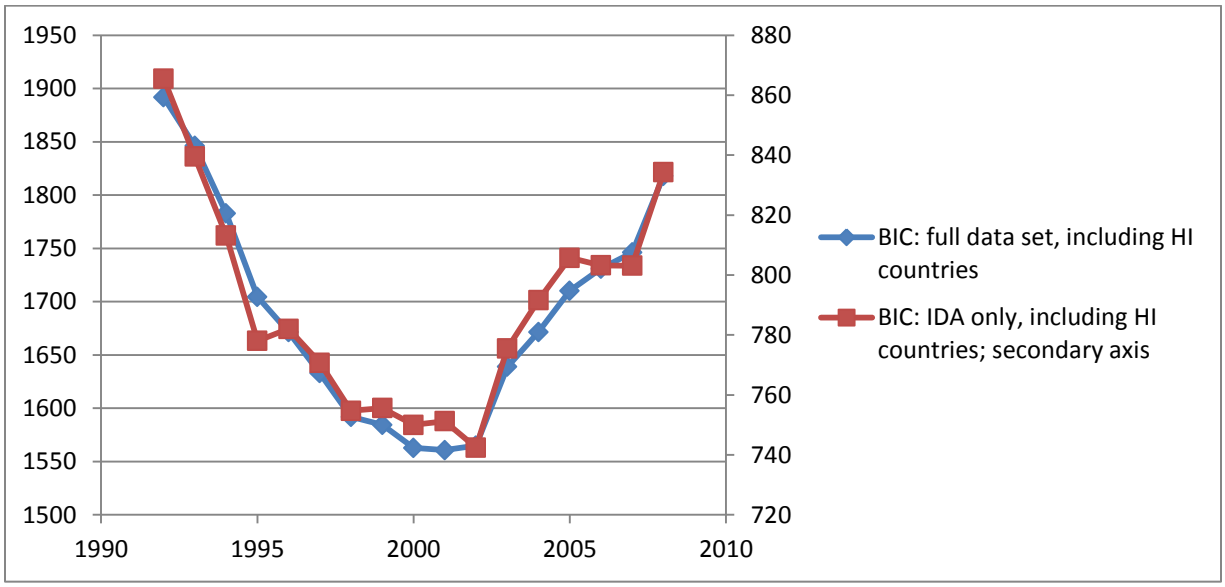
Transformed data: Comparison to least squares regression

The comparison of the IDA, IBRD, and the Blend dataset and time series and least squares projections shows that the dataset deviated noticeably from a linear trend around 2004. Note that the time series projection was a constant trend, equivalent to the least squares projection.



BIC as a function of interrupted year (including Heavy Influence Countries): Log transformed.

The BIC curves show minimums between 1998 and 2002 for both curves with the lack of a clearly defined minimum as seen in other BIC curves.



Estimated coefficients from linear mixed model for optimal year.

IDA, IBRD, Blend countries:

Year: 2001

β_2 (interrupted intercept): 0.04445 (p= 0.4832)

β_3 (interrupted slope): -0.07193 (p<0.0001)

IDA only countries:

Year: 2002

β_2 (interrupted intercept): -0.1714 (p= 0.2168)

β_3 (interrupted slope): -0.09703 (p=0.0024)

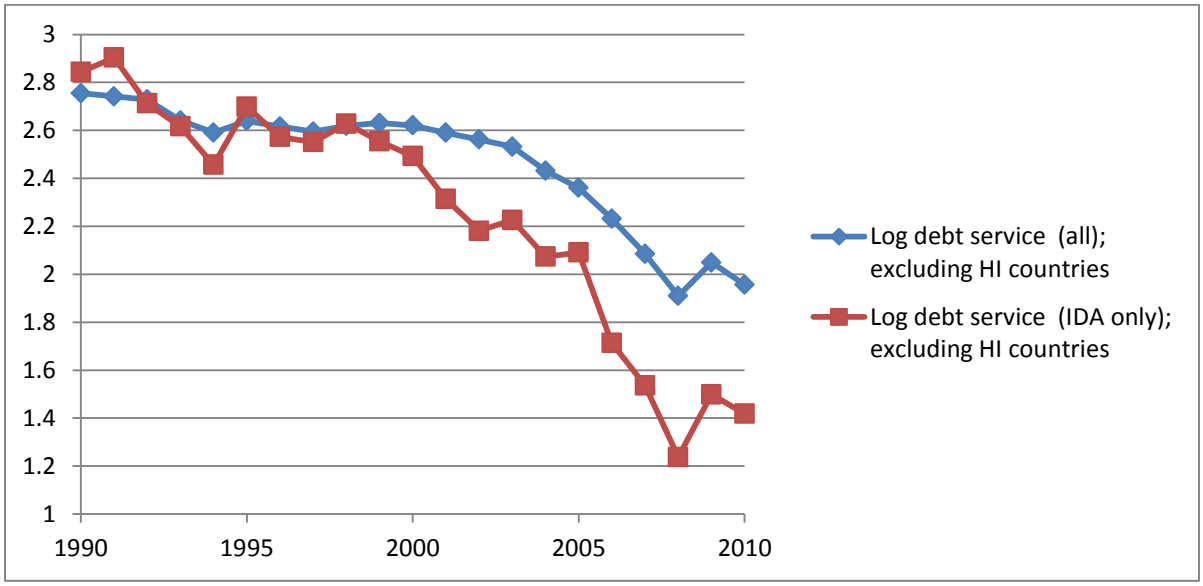
Heavy Influence Countries Identified:

IDA, IBRD, Blend: Romania

IDA Only: Sierra Leone, Vanuatu

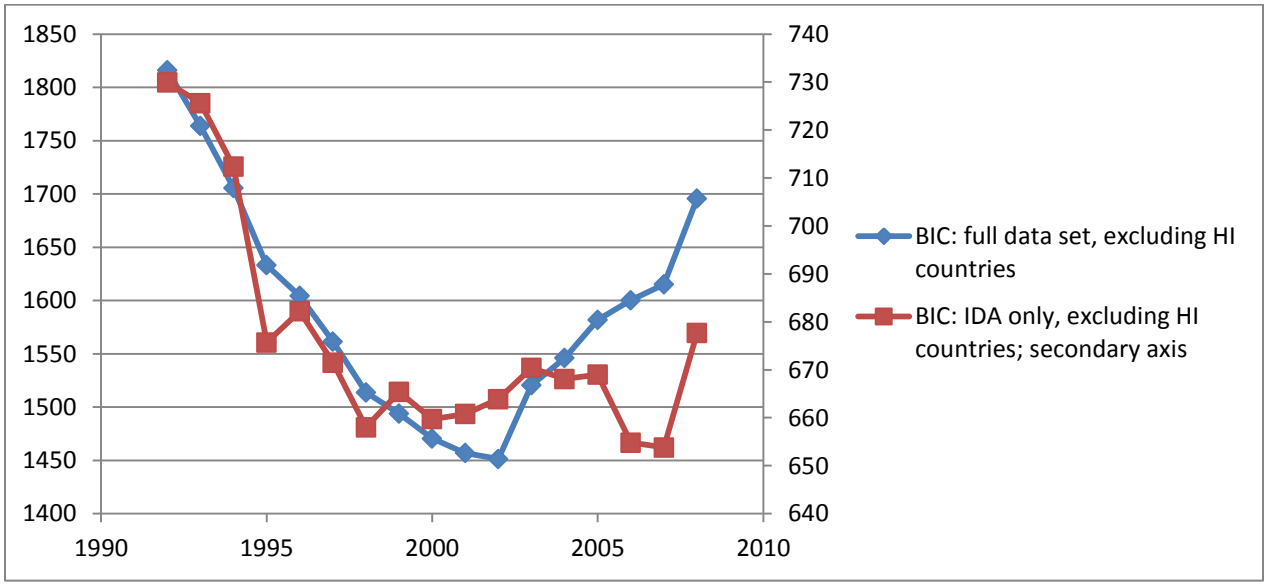
Transformed data (heavy influence countries removed):

After removing the heavy influence countries, the transformed data has the same basic shape with a slope change in the IDA, IBRD and Blend around 2000 and a sharp interrupted intercept or interrupted slope change around 2005 for the IDA only dataset.



BIC as a function of interrupted year: Log transformed removing heavy influence countries

The BIC curve for the IDA, IBRD and Blend dataset has a clear minimum at 2002 while the IDA curve lacks a clear shape or minimum (lowest value is 2007).



Estimated coefficients from linear mixed model for optimal year. Excluding Heavy Influence Countries

The regression results show a significant interrupted intercept in 1997 for the IDA only countries and a significant deceleration in the IDA, IBRD and Blend countries starting in 2002.

IDA, IBRD, Blend countries:

Year: 2002

β_2 (interrupted intercept): 0.01866 (p=0.7757)

β_3 (interrupted slope): -0.07354 (p<0.0001)

IDA only countries:

Year: 2007

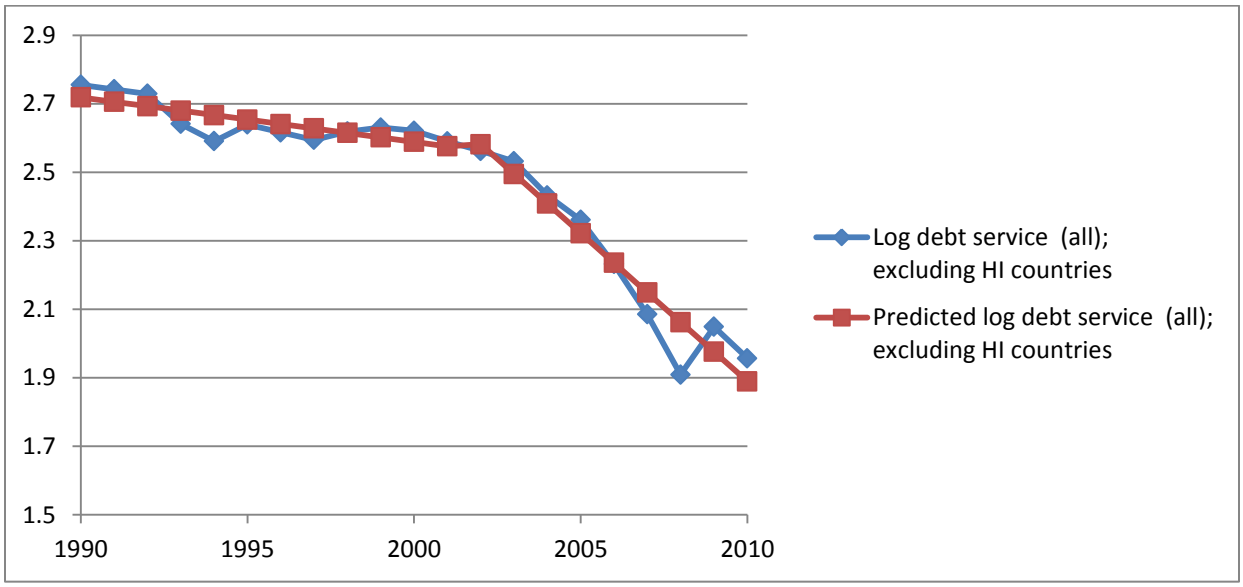
β_2 (interrupted intercept): -0.5062 (p <.0001)

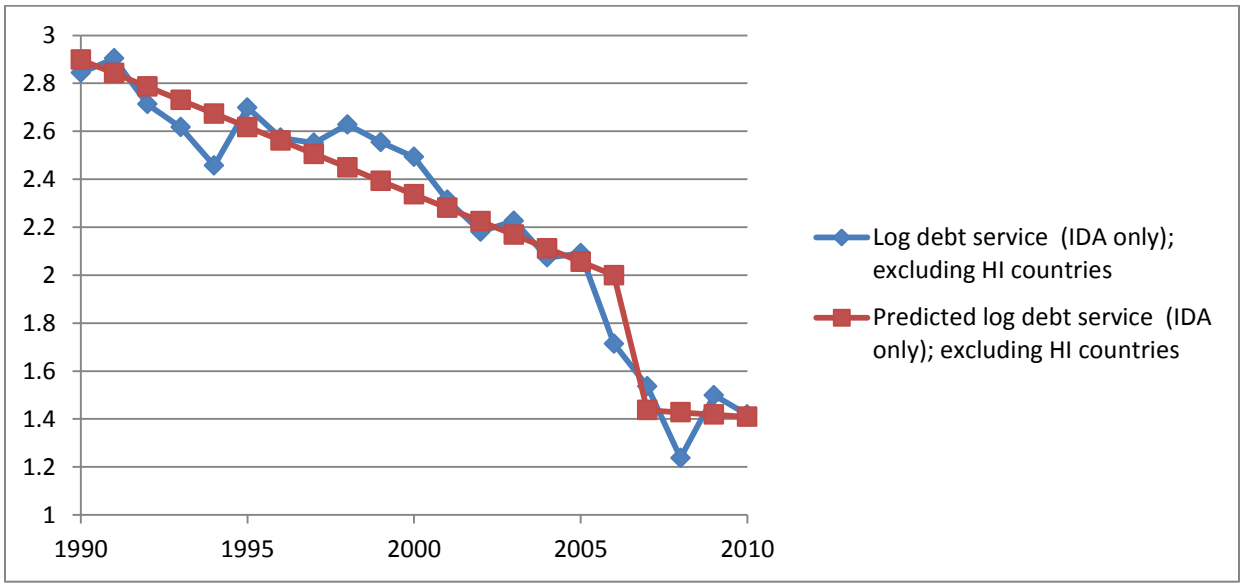
β_3 (interrupted slope): 0.04679 (p=0.3766)

Model fit from linear mixed model for optimal year. Excluding Heavy Influence Countries

Overall the data was not as well fit by the models as some of the other datasets. The absolute percent deviation was less than 5% for all but one data point in the IDA, IBRD and Blend dataset but exceeded

5% for seven data points in the IDA only dataset. This relatively high absolute percent deviation is related to the data having values close to zero.





Adding Non-Linear Fixed Effect:

The introduction of the fixed effect of year^2 into the models did not change the conclusions for either the IDA only or the IDA, IBRD and Blend models; following the addition there was still a statistically significant interrupted slope for the IDA, IBRD and Blend dataset and no significant change for the IDA only dataset.

Appendix D: Heavy Influence Country Summary by Indicator

The identification of statistically heavy influence countries may be useful in identifying countries that have patterns of acceleration/deceleration that differ significantly from that of other countries. These heavy influence countries may be the source of leading or lagging practices or may have experienced internal issues that produced results significantly different from other countries.

Target Indicator	IDA, IBRD and Blend
1B Employment-to-population ratio	Bosnia and Herzegovina, Lesotho, Moldova
1B GDP per person employed	Armenia, Bosnia and Herzegovina
3A Percent Women In Parliament	Belize, Jordan, Kiribati, Kyrgyz Republic, Micronesia, Fed. Sts., St. Kitts and Nevis
4A Infant mortality rate	Latvia, Botswana, Namibia, Rwanda, South Africa, Swaziland
4A % 1 year-old immunized against measles	Congo, Rep., Ethiopia
4A Under-five mortality rate	Haiti, Rwanda, Botswana, South Africa, Swaziland
5B Adolescent birth rate	Korea, Rep, Maldives, Uzbekistan
6A HIV prevalence aged 15-24 years	Russian Federation
6C Incidence of tuberculosis (per 100,000 people)	Antigua and Barbuda, Kiribati, Palau, St. Kitts and Nevis
7A CO2 emissions (metric tons per capita)	Equatorial Guinea, Namibia
7A CO2 total (kt)	Equatorial Guinea, Namibia
7B % terrestrial and marine areas protected	Congo, Rep.
7C Improved sanitation (urban)	Cambodia, Central African Republic, Comoros, Haiti, Tanzania
7C Improved sanitation (rural)	Benin, Eritrea, Ethiopia
7C Improved water (urban)	Angola, Cambodia, Eritrea, Guinea-Bissau, Mauritania, Mongolia
7C Improved water (rural)	Afghanistan, Ethiopia
8A Net ODA (% of GNI)	St. Kitts and Nevis, Turkey
8A Net ODA received (current US$)	Bosnia and Herzegovina, St. Kitts and Nevis, Timor-Leste
8D Total Debt Service	Romania

Target Indicator	**IDA only**
1B Employment-to-population ratio	Honduras, Lesotho, Moldova
1B GDP per person employed	Angola, Congo, Dem. Rep., Moldova
3A Percent Women In Parliament	Kiribati, Kyrgyz Republic, Micronesia, Fed. Sts.
4A Infant mortality rate	Lesotho, Rwanda, Haiti
4A % 1 year-old immunized against measles	None
4A Under-five mortality rate	Lesotho, Rwanda, Haiti
5B Adolescent birth rate	Burundi, Maldives, Mozambique
6A HIV prevalence aged 15-24 years	None
6C Incidence of tuberculosis (per 100,000 people)	Kiribati, Mali, Vanuatu
7A CO2 emissions (metric tons per capita)	None
7A CO2 total (kt)	None
7B % terrestrial and marine areas protected	Congo, Rep., Kiribati, Somalia, Sudan, Tonga
7C Improved sanitation (urban)	Central African Republic, Haiti
7C Improved sanitation (rural)	Benin, Eritrea, Ethiopia
7C Improved water (urban)	Cambodia, Eritrea, Guinea-Bissau, Mauritania
7C Improved water (rural)	Afghanistan, Ethiopia
8A Net ODA (% of GNI)	Angola, Congo, Dem. Rep., Congo, Rep., Cote d'Ivoire, Nigeria
8A Net ODA received (current US$)	Timor-Leste
8D Total Debt Service	Sierra Leone, Vanuatu