Stages of Development and Evolving Constraints to Growth

This draft: April 19, 2015

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Abstract:

Why do some countries grow faster than others? Do countries in the middle-income range face especially difficult challenges producing consistent growth? Using a transition matrix analysis on decade-level growth rates, we find that the data clearly reject the idea that middle-income countries either have a high absolute probability of being stuck where they are or have a higher relative probability of being stuck than the low- or high-income groups. In this sense, the notion of a "middle-income trap" is not supported by the data. However, countries in a given income range have different fundamentals and policies, and the relative growth across countries may depend on these variables. Since development economists and practitioners have proposed a long list of variables that could affect growth, we employ a recently developed non-parametric classification technique (conditional inference tree and random forest) to decipher their relevance and relative importance. We find that the list of variables that can help distinguish fast- and slow-growing countries is relatively short, and varies by income groups. For low-income countries, favorable demographics, macroeconomic stability, good education system, and good transport infrastructure appear to be the most important separating variables. For middle-income countries, favorable demographics, macroeconomic stability, sound global economic environment, and openness to FDI appear to be the key discriminatory variables. This framework also yields conditions under which countries in the low- and middle-income range are trapped or even move backwards.

JEL classifications: C14, C30, F01, F60, O11, O43
Key Words: Economic Growth, Growth Determinants, Middle Income Trap, Infrastructure, Conditional Inference Regression Tree

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Acknowledgements:

The views expressed in this paper are those of the authors and do not necessarily reflect the views and polices of the Asian Development Bank or its Board of Governors or the governments they represent. The authors would like to thank Orlee P. Velarde and Lea R. Sumulong for their excellent research assistance. The authors are responsible for any errors in the paper.

1. Introduction

Are low-income countries likely stuck in a poverty trap? Is a typical country in the middle-income group likely to be trapped in the middle income status forever unable to attain a high absolute level of income? Perhaps more importantly, within any given income group, why do some countries grow faster than others? Are there clear and quantifiable indicators that will separate fast growing economies from slow growing ones? These are the questions that this paper will investigate.

The notion of middle-income trap has gained attention of policy makers and researchers. While lacking a formal definition, it may be thought of as stating that middle-income countries have a low probability of sustaining sufficient growth rates to join the high-income group. The argument is mostly based on descriptive analysis. For example, Eichengreen, Park, and Shin (2013) documented that the economic growth tends to slow down near two modes of $10,000–$11,000 and $15,000–$16,000 in 2005 purchasing power parity (PPP) terms, respectively; [Felipe, Abdon, and Kumar (2012) defined the middle-income trap as the situation where a country spends more years than an arbitrary threshold in one particular income group. For example, it is regarded as "trapped" if it spends more than 28 years in lower-middle-income status or more than 14 years in upper-middle-income status.]

If one follows a dictionary definition of a trap as a situation that is difficult or unable to exit once a country gets in, we will document in the first part of the paper that the data do not support any notion of an unconditional middle income trap. That is, a middle income country that grows at an average or median rate of the middle income group will clearly and surely become a high income country. In other words, in the data, a typical middle income country is not expected to be stuck or trapped in the middle income status. The same thing can be said about a typical low income country because the mean or the median growth rate is clearly positive. The only unconditional trap in the data is a "high income trap." That is, because the median or the mean growth rate of high income countries is also positive, once a country enters the high income club, it is expected

to stay there forever if it is to follow the mean or median growth rate of that group.

If we instead look at the chance that a middle income country catches up with the income level of a contemporaneous very rich country, say the United States, we will find that the chance becomes less favorable. We will document that, in the steady state, there is a distribution of relative incomes: some countries will be income leaders, other countries will have lower relative incomes, and there will be no absolute convergence. Because the income level of the income leaders (say, the United States) is a moving target, this pattern does not mean that a typical middle income country cannot grow beyond the income level that defines the ceiling of the middle income group. A country whose income is forever only 75% of the United States can nevertheless grow very rich (as long as the United States keeps growing as it has been doing in the past).

We are not the first people to discover these patterns in the literature. For example, Robertson and Ye (2013) showed that a middle income country's per capita income relative to the reference country tends to lye within a band. Aiyar et al. (2013) report that a typical country in the middle-income group has a higher frequency of deviations from the growth path defined by conditional convergence when compared with countries in the other two groups.

Im and Rosenblatt (2013) employed transition matrices in the Maddison database over 1950–2008, and found no support for the notion of a middle-income trap in either absolute or relative terms.

Our paper differs from the existing literature in three important dimensions. First, instead of focusing solely on the unconditional income transition or economic growth slowdown (as did, for example, Eichengreen, Park, and Shin (2013), Felipe, Abdon, and Kumar (2012), and Im and Rosenblatt (2013)), we examine what fundamentals and policies can separate fast- and slow-growing economies in a given income group. Second, as far as we know, this is the first attempt to employ a non-parametric classification scheme—regression tree and random forest—in analyzing economic growth. With this method, we can not only handle more than 20 variables, but we can also tolerate missing data and do not have to make assumptions about the distribution

of random shocks. Third, rather than defining a "trap" or "slowdown", or assuming that any incremental change in a given conditional variable always has the same effect on growth, we examine growth rates directly and let the data speak for itself on whether some of the effects are nonlinear or not.

It is useful to compare our paper with other related ones. Aiyar et al. (2013) examine the impacts of factors such as institutions, demographics, macroeconomic environment, and economic structure on economic slowdown. To deal with the small number of observations and large number of potential right-hand side variables, they use the probit model to include one set of right-hand side variables at a time, which seriously limits the credibility and generalization of their results. Rudengren, Rylander, and Casanova (2014) discuss the roles of governance, education, and other factors in economic growth. However, they only make some qualitative arguments without providing formal tests or analytical evidence.

The rest of this paper is organized as follows: Section 2 discusses the unconditional economic transitions in the long run; Section 3 presents the evolving constraints analysis by regression tree and random forest; Section 4 simulates regression-tree-based transition matrices; and Section 5 concludes.

2. (Unconditional) Economic Transitions in the Long Run

We measure income levels by real GDP per capita from the Penn World Table 8.0. Table A1 in the Appendix lists real GDP per capita for 107 countries in 1960, 1980, and 2011.[1] We categorize all countries into five income groups: "Extremely Low Income" with real GDP per capita less than or equal to $1,096 (ELI); "Low Income" with real GDP per capita of $1,096–$2,418 (LI); "Lower-Middle Income" with GDP per capita of $2,418–$5,550 (LMI); "Upper-Middle Income"

[1] While the World Bank's GDP in PPP terms is measured based on a single-year PPP benchmark, the Penn World Table uses chained PPPs. 2011 is the latest year included in Penn World Table 8.0.

with GDP per capita of $5,550–$15,220 (UMI); and "High Income" with GDP per capita greater than or equal to $15,220 (HI). $2,418 is equivalent to the World Bank's cut-off line between low-income and middle-income countries. In addition, another category was included, extremely low-income countries, which comprise countries with per capita income below $3/day in 2005 PPP or $1,096/year in 2005 PPP terms. The income of the United States in 1960 ($15,220) was used as the threshold for classifying high-income countries. Furthermore, the threshold for lower- and upper-middle-income countries was also calibrated so that there are about the same number of countries in the lower- and upper-middle-income categories in 1960, which resulted in a cutoff of $5,550. Additional details on the mapping between our cut-off lines and the World Bank's classification can be found in the Appendix.

In Figure 1, we plot log GDP per capita in 2011 against that in 1960. We impose the thresholds that separate middle-income from low-income countries, and high-income from middle-income countries. In terms of overall growth performance from 1960–2011, countries in a given income group fall into one of the following scenarios: 1) those below the 45 degree line, which experienced a negative growth rate; 2) those above the 45 degree line but still belonging to the same income group; and 3) those with a positive growth rate and have moved up to a higher income group. All countries that belonged to the middle-income group in 1960, except for Zambia, enjoyed positive growth rate with more than half of them moving up to achieve high-income status (27 out of 41) in 2011. The scenario for the low-income group is much worse: 63 countries in 1960 started as low-income countries, 29 remained as low-income countries in 2011, among which 8 countries experienced negative growth rate.

All Asian and Pacific members (in red dots) experienced positive growth rates, with a majority of them managing to move out of low-income status to at least the lower-middle income group. The Republic of Korea, Singapore, and Taipei,China have burst past middle-income status and attained high-income status.

From Figure 1, the middle-income group does not exhibit any unconditional trap in the sense of non-growth for a majority of countries. We probe it further by looking at the short-term transition using a shorter time span starting from 1980. A similar pattern is shown in Figure A1 in the Appendix. All-middle income countries enjoyed positive growth rate while some of the low-income countries experienced negative growth rate. Since a majority of low-income countries also have positive growth, the unconditional probability of being trapped is also low.

After examining growth patterns in absolute terms, we turn to relative measures. As shown in Figure 2, the threshold for low-income countries is 16% of the 1960 US income level.[2] The threshold for separating upper-middle-income and high-income countries is the 1960 US income level.

The countries below the 45 degree line grew slower than the United States. Compared to Figure 1, there is less catch up and more countries remain where they are in terms of their income relative to that of the United States. As is well known, some Asian economies managed to move up to the higher-income group even in relative terms.

2.1 Transition Matrix and Ergodic Distribution

We now investigate transition probabilities of different income groups by introducing the transition matrix and its asymptotic distribution or the Ergodic distribution.

We group countries by their per capita income at the beginning of a decade. There are five income groups: extremely low, low, lower-middle, upper-middle, and high. For each income group, we compute the probabilities that a typical country moves to each of the possible income

[2] $2,418/$15,220

groups over a decade. These probabilities are summarized by a transition matrix in Table 1.[3]

The number in a given cell reports the probability that a typical country with an income status in the row moves to the income status in the corresponding column over a decade. For example, the first cell says that an extremely low-income country (ELI) has an 82% probability to remain in the same income status after a decade, and the second cell says it has an 18% probability to become a low-income country (LI) in a decade. The remaining cells in the first row indicate that there is zero probability of moving up any further in a decade. A country that started as an upper-middle-income country (UMI) has a 70% probability to stay in the same income status and 30% probability to move up as high-income country (HI) at the end of the decade.

Based on the transition matrix, we can see that for all the non-high-income groups, the probability of moving up to a higher-income level in one decade is greater than 15%. The following question would be, in the long run (allowing enough time to grow), whether all countries can end up in the high-income group eventually. To address this question, we employ the Ergodic distribution.[4] As shown in the last row of Table 1, in the long run, regardless of development status from where economies begin, they will all end up in the high-income group (with probability of 1).[5] In other words, in the long run, there is neither a low-income trap, nor a middle-income trap. The trap we can see in the data is a high-income trap. That is, once a country reaches high income status, it is expected to stay there forever.

The Ergodic distribution tells us the distribution of income status across countries over the very long run. But how long does it take to reach the very long run? From the transition matrix, we

[3] The decade average transition matrix is estimated based on the 5-decade transition matrices 1960–1970, 1970–1980, 1980–1990, 1990–2000, and 2000–2010 from 1960 to 2010 by employing a numeral optimization program. Instead of taking the simple average for the five transition matrices (which suffers from Jensen's Inequality), we estimate a transition matrix that can give us an exact five decade duration transition matrix (entry in 1960 and exit in 2010) by taking its power 5.

[4] Ergodic distribution matrix $=$ Transition Matrix^{+r}. Empirically, we use power 2000 to approximate the Ergodic distribution matrix.

[5] We also check the robustness of the results by using a transition matrix with 5 decades as the duration (1960–2010). The result does not change.

estimate that it will take 44 decades for all the extremely low- and low-income countries to move up to the next income level or higher, while it will take 48 decades for all countries to achieve either an upper-middle-income or a high-income status.

We can also compute, based on the transition matrix, the number of decades it takes for a given percentage (e.g., 50% or 90%) of countries in an income group to move out of their current status and into higher income groups.

We summarize the results in Table 2. For extremely low-income countries, it takes 4 decades for half of them to move to higher income groups. Similarly, for low-income, lower-middle-income, and upper-middle-income countries, it takes 3, 3, and 2 decades, respectively, for half of the countries to move to a higher-income status.

If we want to see 90% of the countries in a group move to higher incomes instead of 50%, naturally, the required durations would be longer. For the four developing country groups from the extremely low-income to the upper-middle-income group, it takes 14, 12, 8, and 7 decades respectively, to move into the next income level or higher. We extend this discussion to consider: (i) the transition trend based on decade-specific transition matrices; and (ii) the effect of financial crisis, both of which are included in the Appendix.

2.2 Ergodic Distribution Analysis on Convergence in relative terms to the US

So far, we discussed the transitions based on absolute terms. Next, we assess the transition pattern relative to the US income level. We divide the groups into four categories: 16% of US real per capita income as low income, 16%–36% of US real per capita income as lower-middle-income, 36%–75% of US as upper-middle-income, and 75% of US as high-income indicating catch up

with the US.[6]

Table 3 presents the decade average transition matrix relative to US income from 1960 to 2010. For the low-income group, the probability to enter into lower-middle-income category relative to the US is 8%. The probability for an upper-middle-income country to catch up with the high-income group is 22%. The last row of Table 3 shows the corresponding Ergodic distribution. The last column of the Ergodic distribution shows that 67% of countries cannot exceed 75% of US income in the long run. In relative terms to US income, the "middle-income trap" does exist.

2.3 Long-horizon Analysis with Maddison Data

In Maddison's data, GDP per capita of the US in 1990 international Geary-Khamis dollars for the year 1960 is $11,328. Aligning with the absolute cut-off lines measured by 2005 PPP international dollars, we use 16%, 36%, and 100% of the US level as cut-off lines to calculate the cut-off line for income groups in 1990 international Geary-Khamis dollars. These correspond to the following categories: low-income (less than $1,812)[7]; lower-middle-income ($1,813–$4,078); upper-middle-income ($4,079–$11,327); and high-income ($11,328 and above).

Table 4 shows the 50-year duration transition matrices for 1850–1900, 1900–1950, and 1950–2000. Compared with 1850–1900 and 1950–2000, in 1900–1950, the low-income group and lower-middle-income group had the highest probability to move onto the next income level or higher. For the period of 1950–2000, the probability for lower-middle-income countries to move to high-income is 37% while the probability for the upper-middle-income countries to achieve high-income status is 81%. The Ergodic distribution is consistent with the Ergodic distribution results using the Penn World Table 8.0 data. The probability for all income groups ending up in

[6] The reason we have 16% as the cut-off line is to be consistent with the absolute analysis, in which, $2,418 (the line to differentiate low-income and lower-middle-income in 1960) divided by $15,220 (US income in 1960) is 0.16. The relative lower-middle-income line is 0.36 (dividing $5,500, the line differentiating lower-middle- and upper-middle-income, by $15,220). We choose 75% as the line to indicate a reasonable range with the US.

[7] This corresponds to $2,418 in the Penn World Table data.

the high income group is 1.

3. Evolving Constraints to Growth: A Perspective from Regression Trees and Random Forests

One implied assumption for the Ergodic distribution is that transition probability from one income status to another are the same for all countries within a given income group. However, for real growth progress, there is heterogeneity across countries. These dimensions of heterogeneity could be very interesting if they are systematically related to fundamentals or policy choices. In this section, we investigate factors affecting economic growth and their relative importance at different stages of development.

The extant growth literature suggests a long list of factors that have been hypothesized by researchers, policy makers, and practitioners as important factors for growth, especially for low-/middle-income countries. In this camp, there are several papers, such as Rudengren, Rylander, and Casanova (2014) who made some qualitative arguments about the roles of governance, education, and other factors in economic growth without providing formal tests or analytical evidence, and the above-mentioned Aiyar et al. (2013). For the general categories of factors, in addition to the well-recognized factors recommended by existing literature, we particularly refer to the Asian Development Bank's Eight Key Actions for Development (see the Appendix) and the Washington Consensus. When we did the variable selection, we also considered the availability of variables. Most of the variables we included go back to 1960.

3.1 Variables That Could Alter Growth

We now discuss variables that may separate fast growing and slow growing countries. This list is guided by the (vast) existing literature on determinants of growth.

The initial income level is commonly accepted as a determinant of the growth rate, and is implied by the Solow growth model and confirmed by a vast empirical literature (see a summary by Barro and Sala-i-Martin, xxx). Real GDP per capita at the beginning of each decade is used as the initial income. We expect countries with higher initial income to have a lower growth rate, and those with lower initial income to have a higher growth rate. This expectation is in line with findings in the literature. For example, Pritchett and Summers (2014) argued that there is a strong regression to mean trend in growth rates across countries.

The demographics is considered basic driving factors of economic growth, as have been explained in growth theory. We include the share of population 15–64 years old (labor force age population share) and the labor force population growth (difference between the natural logarithm transformed size of population aged 15–64 between the end and the beginning of the decade) as the demographic variables. Data comes from the World Bank's World Development Indicators. The contributions of population age structure come from two channels: higher labor supply and higher saving rates as pointed out by Bloom et al. (2007). Empirical evidence has likewise been documented by Bloom et al. (2000, 2003, and 2007).

Infrastructure is considered a key input in a country's investment climate. When Prime Minister Mody of India and President Jokowi of Indonesia came to power in 2014, they both stressed investing in infrastructure as a key to listing their respective countries' growth rates. Straub (2008) suggests that infrastructure promotes growth directly through productivity improvements. Indirect channels include: labor productivity improvement by reducing time to commute, health and education improvement, economies of scale and scope, etc. Following the recent trend of using direct measures of infrastructure development rather than infrastructure investment (see Egert, Kozluk, and Sutherland (2009) and Calderón, Moral-Benito, and Servén (2014)), we use the

indicators developed by Calderón, Moral-Benito, and Servén (2014), which include: (1) electricity generating capacity in gigawatts per thousand workers; (2) total length of paved roads in kilometers per thousand workers; and (3) total length of rail in kilometers per thousand workers.

We use average years of total schooling from the Barro-Lee database to represent *human capital*. That better education is associated with higher growth is a common assertion. Under the general umbrella, some researchers support the view that investment in primary and secondary education is more important, using the 30 years after World War II's Europe compared with the same period of the US, while others support the view that investment in higher education is more important as observed by Aghion et al. (2009). Instead of using investment in education, we use achieved education years as the indicator. Limited by data availability, we did not consider education quality, although the recent literature pointed out that cognitive skill of the population are related with long-run economic growth; see, for example, Hanushek and Woessmann (2008).

For *the macroeconomic environment and policy*, we include inflation rate, government debt share, and the number of crisis episodes. The inflation rate is consumer price inflation from the World Bank's World Development Indicators. Both adopted from Reinhart and Rogoff (2009), the government debt share is the gross central government debt to GDP ratio and the total number of crisis is the sum of currency crises[8] and bank crises[9] within the decade. We exclude inflation crises and external and local debt defaults from the Reinhart and Rogoff (2009) crisis data to avoid overlapping with the indicators of inflation and total government debt.

[8] Currency crisis is defined as: currency crashes (an annual depreciation versus the US dollar (or the relevant anchor currency – historically the UK pound, the French franc, or the German DM, and presently the euro) of 15 percent or more); currency debasement (a reduction in the metallic content of coins in circulation of 5 percent or more or a currency reform where a new currency replaces a much-depreciated earlier currency in circulation).

[9] A banking crisis is defined as bank runs that lead to the closure, merging, or takeover by the public sector of one or more financial institutions; and if there are no runs, the closure, merging, takeover, or large-scale government assistance of an important financial institution (or group of institutions), that marks the start of a string of similar outcomes for other financial institutions.

Economic openness is represented by the share of exports and imports to GDP (trade share) and the share of net FDI inflow to GDP (FDI share) from the World Development Indicators. A vast literature confirms a positive association between trade openness and growth, but causality interpretation is more controversial (see Rodrik and Rodgriguez, xxx; Frankel and Romer, xxx; Freg, xxx). There are several channels for FDI to affect growth, including: induing a more educated workforce (Borensztein et al., 1998), improving trade openness (Balasubramanyam et al., 1996), and improving financial markets (Alfaro et al., 2003). By including the share of net FDI inflow to GDP together with other variables, our framework provides an opportunity to revisit these debates.

The potential importance of *political institutions* in growth is summarized by Glaeser et al. (2004) as follows: with good political institutions (low expropriate risks) in place, there will be greater private sector incentives for investment in human capital and physical capital, which in turn contribute to growth. Well-known papers include Hall and Jones (1999), Acemoglu, Johnson, and Robinson (2001, 2002), Easterly and Levine (2003), Dollar and Kraay (2003), and Rodrik, Subramanian, and Trebbi (2002). Following this line, we adopt the political constraint indices usedby Henisz (2000, 2002), which measures constraints on the executives (the president or the prime minister) from legislative, judicial, or other political bodies The estimate ranges from 0 to 1, where zero means no political constraint (high political discretion) and it moves toward stricter political constraint as its value approaches one.

For *political stability*, Alesina et al. (1996) documented that in countries and time periods with a high propensity of government collapse (political instability), growth is significantly lower than otherwise. In our analysis, we choose the domestic conflicts indicator from Cross-National Time-Series (CNTS) Data Archive to represent political stability. The variable is a weighted conflict measure using the combination of domestic conflicts such as assassinations, strikes, guerrilla warfare, government crises, purges, riots, revolutions, and anti-government

demonstrations. Higher values of the indicator signal more political instability.

Additionally, we include two more control variables. One is a dummy variable for whether the country is "oil rich". We define a country as oil rich (with value equal to 1) when its fuel exports exceed 40% of its total exports or its fuel exports exceed 15% of its GDP. Data comes from the World Bank's World Development Indicators.[10] Out of 435 country-decade combinations, 50 observations were labeled as oil rich.

For *global economic environment*, we construct an indicator of global economic growth using US growth rate before 1980 and the population-weighted average growth rate of Japan, Germany, and the US for and after 1980. We have an average annual growth rate of 3.4% for the 1960s, 2.2% for the 1970s, 2.1% for the 1980s, 2.6% for the 1990s, and 0.7% for the 2000s.

We use real GDP per capita from the Penn World Table 8.0 to measure economic growth. Most data are converted to decade average values, unless otherwise specified. The first decade is from 1960-1969. The annual growth rate is the compounded rate calculated based on the decade growth rate. We include country-decades with at least 15 variables available (out of 17 potential predictors), which resulted in a total of 453 observations in the dataset. The dataset includes 94 countries, with 5 decades for some countries and less than 5 decades for the others.

3.2 Box Whisker Plot and Pair-wise Correlation Analysis

For each income group, we draw the Box Whisker Plots for each variable and present them in Figure 3. The middle-income countries have the highest decade median growth rate at 27% whereas the low-income countries have the lowest decade median growth at 11%, but with the largest variation. There are clear strong associations between income levels (low/middle/high)

[10] Since we use export share as the measure, countries with oil refining as their major business might be included in this category.

and years of schooling, political constraints, electricity generating capacity, paved road, and railway, that is, higher levels of each factor are associated with higher income groups. For inflation, the median levels of the low-income and middle-income groups are close to each other, with a higher degree of variation among the middle-income group. For trade share, all three income groups share similar median levels, with the middle-income group having the largest variation. For FDI share, the high-income group has the highest median and largest variation. For domestic conflicts, the low-income and middle-income groups faced relatively worse situations than the high-income group. For government debt share, the high-income group has the highest median level at around 47%, while the low-income group has the largest variation. For the total number of crises, the high-income group is in better situation. For labor force population growth, the low-income group has the highest decade growth rate at 25% while the high-income group has the lowest decade growth at 7%.

The Box Whisker Plots show heterogeneity in variables among different income groups, indirectly supporting our hypothesis that different subsets of factors matter more for growth among countries in different income groups. Based on this hypothesis, we constructed the pair-wise correlation matrices for low-income, middle-income, and high-income groups. In Table 5, the red color highlights correlations between the growth rate and the factors (the first row) which are either higher than 0.15 or lower than -0.15. The second row to the last row show the correlations between factors. The green color highlights correlations that are either higher than 0.4 or lower than -0.4. As shown in red highlight, different variables are correlated with the growth rate for different income groups: (1) for the low-income group, years of schooling, political constraints, share of population 15–64 years old, government debt share, and paved roads have higher correlations with growth than other factors; (2) for the middle-income group, FDI share, share of population 15–64 years old, government debt share, crisis indicator, and growth of working age population have relatively higher correlations; and (3) for the high-income group, initial income, trade share, share of population 15–64 years old, and crisis indicator

correlate more with growth.

The correlation observations show further evidence supporting our hypothesis that conditional on the stage of development, driving factors of economic growth vary among income groups. We also see that correlations between factors have different patterns across countries with different income levels (as shown in green color). The relatively high correlations between factors raise particular challenges for estimations, especially for linear regression analysis. In the following examination, we employ a Conditional Inference Regression Tree and Random Forest approach, which have the advantage of assessing the contribution of each factor conditional on the correlated predictors.

3.3 Conditional Regression Tree Analysis

The regression tree analysis is a data driven machine learning method.pioneered by Breiman (1984) and others and refined in the subsequent literature. The general idea of a regression tree analysis (in the context of growth prediction) is this: the algorithm searches for all possible binary splitting points for each predictor (i.e., the independent variables we consider to affect economic growth), and chooses the one split point of the predictor that yields the highest gains in predicting growth and uses that particular predictor and splitting point to grow two children branches from the parent's node. Following the same procedures, the algorithm searches and splits the children nodes until any further splitting does not yield any gain in improving predictability. In the final tree structure, the observations will end up in one of the ending nodes. The prediction of growth of each end node is simply the average of the growth of country-decades falling into that node. Therefore, for prediction purposes, we can predict the country with given predictors having the same expected growth as the average growth of the ending node where the country belongs to.

The Conditional Inference Regression Tree, Suggested by Hothorn, Hornik, and Zeileis (2006), is

a refinement of the Regression Tree Analysis by introducing a hypothesis testing in deciding on each split – a split is made if one can reject the null that the proposed split does not improve the predictive power). Because it makes a split of one predictor conditional on other correlated predictors, it overcomes criticisms of the traditional regression tree analysis that favors the choice of correlated predictors to do the splitting method. In the Conditional Inference Tree, searching for the best predictor to make the split and searching for the optimal cut-off split value are conducted separately. First, based on linear statistics proposed by Strasser and Weber (1999), the relation of a variable to the response assessed by permutation tests follows a χ^2 distribution. The null hypothesis is that there is no association between a predictor and the response. With a smaller p-value, the probability to incorrectly reject the null hypothesis is lower. Therefore, in the first step, the variable with the smallest p-value is chosen to do the split. In the second step, the best cut-off point for the most significant variable chosen in step one is determined. For each of the two branches associated with the first split, another variable with the strongest association with the response is searched for. The remaining branches of the tree will grow in the same fashion. To grow the conditional inference tree, we require that all splits have p-values of 0.05 or smaler[11], a minimum number of observations of 7 for each ending node, and a minimum size of 20 in a branch before any splitting.

Figures 4 and 5 show the conditional regression trees for low-income and middle-income countries, respectively. (We skip the investigation of high-income countries so as to focus the analysis on low-income and middle-income countries). In the tree, the variables used for each split and the associated p-values are labeled in each splitting node. For each split, the right branch indicates the branch with values higher than the splitting value of the parent node, while the left indicates the branch with values lower than the splitting value. The ending nodes are shaded with grey color. The number of observations and the predicted growth rate (average of growth rates) are listed. The predicted growth rates are average annual growth rate of country-decades falling in

[11] The estimate is carried out with the package party() in R.

each ending node.

For Low-Income Countries

We pool extremely low-income and low-income countries together and label them as one low-income group. As shown in the Conditional Inference Tree in Figure 4, among all the variables we included in the analysis, the important variables for categorizing growth performance include: demographics (share of population 15–64 years old), macroeconomic environment (inflation), infrastructure (paved road), education (years of schooling), initial income level, and whether the country is oil rich or not.

Based on the ending node results, we further categorize countries into three groups: progressive (expected annual growth rate higher than 3%), near-stagnant (expected growth rate between 0 and 3%), and regressive (expected negative growth rate) countries. For progressive countries, three combinations of variables produce relatively high growth (labeled with blue circles): Conditional on favorable demographics (share of population 15–64 years old higher than 53.7%), if the countries are oil rich, their expected annual growth rate is 6.6%; if not oil rich, but with relatively good education (years of schooling higher than 3.42), an annual growth of 3.3% can be expected. Another group of good performers with expected annual growth rate of 3.9% are the countries with better macroeconomic environment (inflation lower than 17.287%) and sound infrastructure (paved road higher than 1.566 km per thousand workers) when facing unfavorable demographics (share of population 15–64 years old lower than 53.637%).

There are two groups with alarmingly negative expected growth rates (labeled with red triangles). Both are featured with unfavorable demographics (share of population 15–64 years old lower than 53.637%) and an unfavorable macroeconomic environment (inflation higher than 17.287%). When the logarithm transformed initial income is higher than 7.045 ($1,147), the expected

growth rate is more negative at -4.6%, than otherwise at -0.1%.

All other groups have growth rates between 0 and 3%. For all the ending nodes, we listed two sample countries with the decade and the actual growth rates in parentheses. More detailed information on country decades included in each ending node, their actual annual growth rate, ending node predicted annual growth rate, and the absolute value of predicted errors are presented in Tables A3 and A4 in the Appendix.

For Middle-Income Countries

For middle-income countries, we pooled the lower-middle- and upper-middle-income countries. As shown in Figure 5, the important variables for middle-income countries in explaining growth performance include: demographics (share of population 15–64 years old), macroeconomic environment (government debt to GDP ratio and the number of crises in the decade), openness (net FDI inflow as share of GDP), global economic growth, and initial income level.

Based on growth performance, similar to the low-income group analysis, we categorize countries into three groups: progressive, near-stagnant, and regressive.

In the progressive group, countries with favorable demographics (share of population 15–64 years old higher than 58.85%), sound macroeconomic situation (government debt to GDP ratio lower than 38.816% and decade number of crises lower than 10), and lower initial income (lower than $5,064) can expect an annual growth rate as high as 7.5%; countries under similar circumstances but with higher initial income (higher than $5,064) can expect less good but still solid performance of either 3.5% (if the share of population 15–64 years old is lower than 64.5%) or 4.7% (if the share of population 15–64 years old is higher than 64.5%). A third group featuring favorable demographics (share of population 15–64 years old higher than 58.85%) but

unfavorable government debt ratio (higher than 38.816%), as long as the decade number of crises is lower than 9, can still expect an annual growth rate of 3.1%.

For countries with unfavorable demographics (i.e., with a share of age cohort of 15-64 in the population to be lower than 58.9%), there are still two groups of countries that have reached a reasonable growth rate. They are on the left half of the graph. One of these groups with a relative low level of government debt (29% of GDP or less) and an initial income of level of $5064 or less has an annual growth rate of 3.7%. The other group, with their high debt/GDP ratios (in excess of 29% of GDP) offset by an open policy towards foreign direct investment (with inflow FDI/GDP at 2.06% or more), produces a growth rate of 4.7%. Since all the progressive groups grow faster than the average of the high income group, they have the hope of catching up with the existing high income countries in due course.

Middle income countries can also produce their regressive group. In particular, for a combination of unfavorable demographics (with the share of population 15–64 yearsis lower than 58.85%), a relatively high government debt (with government debt share greater than 29% of GDP), low FDI openness (with a share of net FDI inflow to GDP lower than 2.061%), and unfavorable global economic environment (global annual growth lower than 2%), of the growth becomes -0.4% a year. Of course, since these countries become poorer over time, they are doing worse than being trapped in a middle-income trap. If their policy choices and fundamentals do not change, in principle, they can slip out of the middle income group and become low income countries again.

Countries with other characteristics can have growth rates between 0 and 3%. While these countries are not formally trapped in a particular income status in terms of their absolute income, their anemic growth rate would leave them behind the existing high income countries as a group in relative terms.

To summarize, for countries in the middle income group, to attain a strong growth rate (with a growth rate higher than the high income group), having a favorable demographic pattern (with a high share of working age population) and prudent macro debt management is helpful. Without a favorable demographic pattern, a combination of prudent macro debt management and openness to FDI can still deliver strong growth. In contrast, macroeconomic instability in the form of frequent crises and insufficient openness to FDI likely lead to anemic or even negative growth rates.

3.4 Robustness Check with Random Forest Analysis

Regression tree is a non-parametric technique. Relative to a linear regression, enjoys several advantages: no required transformation of variables, robustness to outliers, and greater tolerance of missing data without having to impute values. However, results of the regression tree are potentially sensitive to changes in the sample (page 132, Shmueli et al. 2007). To obtain a sense of the results in different subsamples, a random forest technique is proposed and used by Breiman (2001) and Hapfelmeier (2012). A random forest is a combination of many trees, with each tree constructed based on an independently and randomly drawn sub-sample and subject to random errors. Therefore, as the number of trees in the forest increases, the generalization error (by taking the average of the trees in the forest) converges to a limit, which helps yield more robust results compared with a single tree based on the whole sample. Since the size of a sub-sample for each tree in the forest is smaller than the whole sample, the forest does not include the particular tree that was constructed based on the whole sample and presented earlier.

For each income group, we will grow a forest with 1000 trees[12] (based on 1000 randomly drawn subsamples). In defining the parameters to grow the trees, we choose to use the unbiased random forest as suggested by Strobl et al. (2007).[13] For each tree, we require the maximum p value for a

[12] The function of cforest in the package of party in R is employed.
[13] With teststat="quad", testtype="Univariate" defined in the cforest_control.

split to be 5%5, a minimum size for a split as 20, a minimum size for the ending node as 7, and the re-sample size of 90% as the whole sample.

Unlike a regression tree, the results of a random forest are harder to visualize and are summarized in Table 6 instead. The first column ranks the importance of factors based on the frequencies listed in column 3. The frequency pertains to the total number of appearances of each variable in all trees in the forest. The fourth column is the average split value of the corresponding variables. For example, the share of the population 15–64 years old appears 1277 times in the forest and the average of its split value across all its 1277 appearances is 53.77%. As illustrated in the regression tree analysis, for each split, the right branch includes observations with values higher than the split value, while those with lower values are on the left branch. Column 5 lists the average difference of the decade growth rates between observations on the right branch and those on the left branch when the corresponding variable is used for the split. Therefore, if the difference is a positive number, the variable used for the split has a positive association with the growth rate. Using the share of population 15–64 years old as an example, we can say that on average, countries with a share higher than 53.77% has an annual growth rate around 2.54% higher than that of countries with a share lower than 53.77%. The last column is a statistic we constructed to indicate the significance of the results in column 5. They are the frequencies of positive differences against the frequencies of negative differences. With larger differences in the positive–negative votes, we have higher confidence in the results listed in column 5.

We highlight all variables with a total frequency of 600 (out of 1000) or higher. For low-income countries, the share of population 15–64 years old, paved roads, share of net FDI inflow to GDP, population growth, power generating capacity, initial income, whether a country is oil rich or not, years of schooling, inflation, and government debt share are the important variables. The variables shown in the regression tree for the whole sample such as favorable demographics and openness to FDI are all picked up as important variables by the forest, which suggests robustness

of these variables.

In addition, several measures of infrastructure, especially roads and power generation, are often important in subsamples.

One notable difference of the forest results from the regression tree results is the high ranking of the FDI share, power generating capacity, and population growth. The difference between the right and left branches of each split in the regression tree is conditional on the unique tree structure that was constructed based on the whole sample. By contrast, the contribution of each variable (column 5 in Table 6) in the forest is the average of the contributions of all splits using that variable conditional on the tree structures across the forest.

For middle-income countries, variables with frequencies higher than 600 include the share of population 15–64 years old, government debt share, the number of crises in a decade, initial income, share of net FDI inflow to GDP, global growth, political constraints, and inflation. However, for political constraints, the last column of frequencies of positive contributions / negative contributions is 51.87%/48.13%, which indicates no dominating votes, so we dropped it from the list. Again, the variables picked up by the forest cover all variables shown in the regression tree, which suggests that our regression tree results are robust.

We also check the robustness of the random forest results by carrying out estimations with sub-samples, excluding decades of 1970–1980, 1980–1990, 1990–2000, and 2000–2010, one decade at a time. We compare the important variables in each sub-sample with the top ten important variables for low-income countries: among the top ten variables (with frequencies higher than 600) listed in Table 6, nine appear in the top ten list for the sub-sample excluding 1970–1980, nine appear in the top ten list for the sub-sample excluding 1980–1990, eight appear in the top ten list for the sub-sample excluding 1990–2000, and nine appear in the top ten list for

sub-sample excluding 2000–2010.

Among the top eight variables (with frequencies higher than 600) for middle-income countries listed in Table 6, seven appear in the top eight list for the sub-sample excluding 1970–1980, seven appear in the top eight list for the sub-sample excluding 1980–1990, eight appear in the top eight list for the sub-sample excluding 1990–2000, and seven appear in the top eight list for the sub-sample excluding 2000–2010.

Although the results are not based on randomly drawn sub-samples (such as by excluding country decades randomly), they still to some extent lend confidence to the robustness of our forest results. The small variations in the sub-samples may be reflective of the decade-specific features of the growth patterns.

Another robustness check is the use of initial values for all variables at the beginning of each decade, rather than their decade average values to help us address the "endogeneity" challenge. We conducted the exercise and obtained forest results that are similar to the results listed in Table 6.

4. Conclusion: Link the Conditional and Unconditional Analyses

In this paper, we examine the growth performance of countries in different income status. In the first half of the paper, d find no we reject an unconditional notion of a "middle income trap," or a "low-income trap." That is, an average country in either the low- or middle-income group has more than 50% chance to have a positive growth rate. Therefore, given enough time, an average country is always expected to move to a higher-income status. The only trap in the data is a high-income trap in the sense that once a country enters the high-income club, it is always expected to stay there. In the second half of the paper, we find that a relatively succinct list of

variables can separate fast growing and slow growing economies in any given income group.

We now link the conditional results based on the regression trees to the unconditional results based on transition matrices.. We divide the countries into five groups: extremely low-income, low-income, lower-middle-income, upper-middle-income, and high-income countries using the same criteria as in Section 2. In each group, we have three types of countries: progressive (with an expected annual growth rate higher than 3% based on the regression tree), near-stagnant (with an annual growth rate between 0 and 3%), and regressive (with a negative annual growth rate). The results are presented in Table 7.

Conditional on the sample and the regression tree results, we show that for extremely low-income groups, 12 out of 82 country-decades belong to progressive countries, and they have an 83% probability of moving up to the next higher-income group—i.e., the low-income group—within one decade. It only takes 4 years for half of them to move up to the next higher-income groups or 13 years for 90% of them to move up. For these countries, there is clearly no low-income trap. For the near-stagnant countries (60 out of 82), the scenario is much worse; the upward decade transition probability is only 15%. It will take 43 years (142 years) for 50% (90%) of them to move up to higher-income groups. For the regressive group (10 out of 82), i.e., those with negative growth rates, they will never move up to higher-income groups if nothing else changes. With policy choices and fundamentals that characterize the regression group of low income countries (i.e., high inflation and unfavorable demographics), these countries are likely trapped in poverty.

We can perform a similar exercise for the other three income groups. In general, there is no trap for countries in a progressive group. They are expected to move to the next income group within a relatively short period of time. For countries in a regressive group, the negative expected growth rate implies that they may do worse than being simply trapped in their current income

status. For countries in a near-stagnant group because growth is low, they may look like being trapped in their current income status for a long time. One interesting observation is that even for the progressive countries, it takes longer for the upper-middle-income countries to move up compared with the other income groups since the income interval covered by the upper-middle-income group is much wider than the other groups. For example, it takes 54 years for 90% of the upper-middle-income countries to join the high-income club, but only 29 years for 90% of the lower-middle-income countries to move up, and 24 years for 90% of the low-income countries to move up. (In other words, part of the differences in the time it takes to move up are due to the income thresholds one chooses for the income groups.)

Based on what characterizes a progressive group in a given income group, one can also infer the types of changes in policies (and fundamentals) that can help hasten the pace of progress towards a high income status. The regression tree results therefore provide plausible drivers for growth for countries in a given income group. For a given country, when compared its own policy regimes and fundamentals to these growth drivers, the gaps provide hints for plausible priority reform items.

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Table 1. Decade-average transition matrix for 1960–2010 (in %)

	Extremely Low-income	Low-Income	Lower-Middle-Income	Upper-Middle-Income	High-Income
EL	82	18	0	0	0
L	3	72	25	0	0
LM	0	3	68	29	0
UM	0	0	0	70	30
H	0	0	0	0	100
Ergodic distribution for the average decade transition matrix					
	0	0	0	0	100

Table 2. Decades needed for X percent of countries to move up and out of their current group

	Extremely Low-income	Low-Income	Lower-Middle-Income	Upper-Middle-Income
X=0.5	4	3	3	2
X=0.9	14	12	8	7

Table 3.Decade-average transition matrix for 1960–2010 relative to US (in %)

	16% and Below (extremely low and low)	16%–36% (lower-middle)	36%–75% (upper-middle)	75% and above (high)
16% and Below	92	8	0	0
16%–36%	13	72	15	0
36%–75%	0	4	74	22
75% and above	0	2	19	79
Ergodic distribution associated with transition matrices relative to US				
	23	13	31	33

Table 4. Transition matrix based on Maddison data (in %)

1850–1900 (in 1900 International Geary-Khamis dollars)				
	Low	Lower-middle	Upper-middle	High
	$1–$1,812	$1,813–$4,078	$4,079–$11,327	$11,327 and above
Low	52	39	9	0
Lower-middle	0	75	25	0
Upper-middle	-	-	-	-
High	-	-	-	-
1900–1950				
Low	41	50	9	0
Lower-middle	0	21	79	0
Upper-middle	0	0	100	0
High	-	-	-	-
1950–2000				
Low	59	24	15	2
Lower-middle	0	26	37	37
Upper-middle	0	0	19	81
High	0	0	0	100
Ergodic Distribution based on transition matrix of 1950–2000				
	0	0	0	100

Table 5. Panel A. Pair-Wise Correlation Matrix for Low-Income Countries

	Initial Income	Inflation	Schooling	Trade	FDI	Political Contr.	Conflicts	Pop 1564 Share	Debt	Power Gen.	Paved Road	Railway	Crisis	Pop 15-64 growth	Oil Rich	Global Growth
Growth Rate	-0.06	-0.05	0.23	-0.03	0.03	0.2	0.02	0.28	-0.22	0.06	0.17	0	-0.15	0.06	0.14	-0.06
Initial Income		0.06	0.33	0.07	-0.05	-0.03	-0.01	0.15	-0.15	0.26	0.44	0.21	0.05	0.19	0.14	0.18
Inflation			0.14	-0.09	-0.05	0.08	0.08	0.04	0.18	0.01	-0.04	0.15	0.16	-0.02	0.21	0.01
Schooling				-0.01	0.21	0.26	0.11	0.33	0.25	0.34	0.17	-0.05	0.39	0.1	0.24	-0.34
Trade					0.35	-0.09	-0.33	-0.07	-0.13	0.12	0.08	0.02	-0.36	0.02	0.11	-0.09
FDI						-0.02	-0.09	0.13	0.43	0.21	-0.02	0.04	0.03	-0.08	0.12	-0.32
Political Contr.							0.11	0.18	-0.03	0.03	0.08	-0.13	0.17	0.12	-0.07	-0.26
Conflicts								0.13	-0.17	-0.05	-0.02	-0.02	0.14	-0.1	0.03	0.04
Pop 1564 Share									-0.04	0.12	0.1	0.05	0.14	-0.39	0.1	-0.06
Debt										0.3	0.1	-0.16	0.29	0.03	0.22	-0.3
Power Gen.											0.17	0.14	0.2	0.09	0.53	-0.06
Paved Road												0.16	-0.03	0.02	0.01	0.03
Railway													-0.08	-0.08	-0.02	0.25
Crisis														0.16	0.12	-0.06
Pop 15-64 growth															0.08	-0.17
Oil Rich																-0.09

Panel B. Pair-Wise Correlation Matrix for Middle-Income Countries

	Initial Income	Inflation	Schooling	Trade	FDI	Political Contr.	Conflicts	Pop 1564 Share	Debt	Power Gen.	Paved Road	Railway	Crisis	Pop 15-64 growth	Oil Rich	Global Growth
Growth Rate	0.03	-0.11	0.14	-0.06	0.26	0.07	0.01	0.36	-0.34	0.09	0.09	0.06	-0.22	-0.24	0.03	0.09
Initial Income		-0.08	0.48	-0.16	0.14	0.32	-0.26	0.49	-0.11	0.61	0.46	0.35	0.06	-0.46	0.05	0.01
Inflation			0.04	-0.06	-0.07	-0.03	0.04	-0.07	0.39	-0.07	-0.06	-0.03	0.37	-0.1	-0.06	-0.1
Schooling				0.06	0.4	0.3	-0.13	0.58	0.28	0.46	0.34	0.23	0.05	-0.37	-0.14	-0.31
Trade					0.41	-0.16	-0.31	-0.04	0.35	-0.1	-0.16	-0.25	-0.31	0.3	0.16	-0.33
FDI						0.08	-0.21	0.37	0.17	0.03	0.01	-0.01	-0.22	-0.17	0.09	-0.38
Political Contr.							-0.07	0.24	-0.08	0.3	0.19	0.08	-0.04	-0.21	-0.24	0.11
Conflicts								-0.05	-0.16	-0.19	-0.17	-0.11	0.26	0.16	-0.08	0
Pop 1564 Share									-0.02	0.32	0.15	0.1	0.06	-0.64	-0.13	-0.26
Debt										-0.12	0.07	-0.04	0	0.04	0.05	-0.23
Power Gen.											0.42	0.41	0	-0.31	-0.02	0.06
Paved Road												0.44	-0.14	-0.34	-0.14	0.2
Railway													-0.05	-0.23	-0.12	0.29
Crisis														-0.1	0	0.03
Pop 15-64 growth															0.24	-0.01
Oil Rich																-0.11

Panel C. Pair-Wise Correlation Matrix for High-Income Countries

	Initial Income	Inflation	Schooling	Trade	FDI	Political Contr.	Conflicts	Pop 1564 Share	Debt	Power Gen.	Paved Road	Railway	Crisis	Pop 15-64 growth	Oil Rich
Growth Rate	-0.35	-0.17	-0.04	0.23	0.1	-0.12	0.01	0.35	0.06	0.03	0.11	0.01	-0.28	0.11	-0.15
Initial Income		-0.27	0.51	0.25	0.4	0.06	-0.12	0.19	0.09	0.32	0.11	-0.16	0.24	-0.03	0.16
Inflation			-0.29	-0.17	-0.27	0.07	-0.06	-0.4	-0.23	0.1	-0.16	0.12	0.17	0.2	0.03
Schooling				-0.09	0.11	0.16	0.04	-0.04	-0.09	0.28	0.28	0.18	0.08	0.21	-0.03
Trade					0.83	-0.48	-0.3	0.45	0.21	-0.04	-0.19	-0.26	-0.08	0.39	0.33
FDI						-0.36	-0.11	0.36	0.09	-0.08	0.09	-0.16	0.03	0.43	0.17
Political Contr.							-0.29	-0.26	-0.26	0.14	0.06	0.01	-0.02	-0.24	-0.14
Conflicts								-0.02	0.39	-0.42	-0.14	-0.03	0.25	0.05	-0.19
Pop 1564 Share									0.3	-0.18	-0.19	-0.13	-0.08	-0.09	-0.12
Debt										-0.25	-0.25	-0.26	0.14	-0.27	-0.06
Power Gen.											0.25	0.35	0.01	0.01	0.48
Paved Road												0.36	0.02	0.03	-0.09
Railway													-0.23	0.26	-0.07
Crisis														-0.22	0.08
Pop 15-64 growth															0.12

Table 6. Conditional Inference Forest Results with 1000 Trees in the Forest with P<=0.05

Low-Income

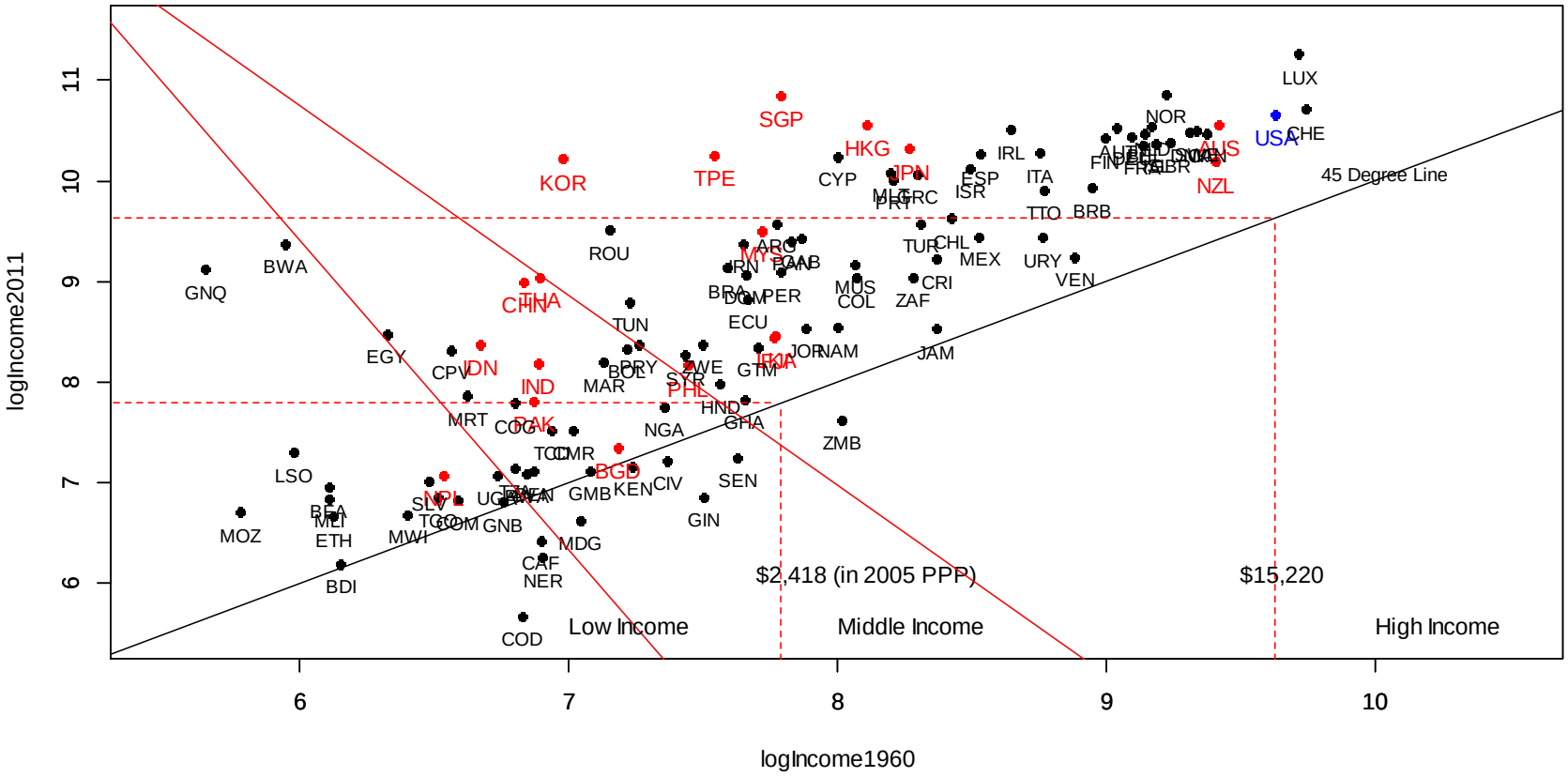
Rank	Factors	Total frequency	Average split value	Difference of growth between nodes with higher/low value than the splitting value (decade growth rate)	Frequencies of positive contributions / negative contributions (in %)
(1)	(2)	(3)	(4)	(5)	(6)
1	**Population share (15–64)**	**1277**	**53.77%**	**2.54**	**93.89/6.11**
2	**Paved Road** (km/1,000 workers)	**1181**	**1.39**	**1.21**	**69.18/30.82**
3	**FDI share**	**955**	**1.83%**	**0.79**	**65.03/34.97**
4	**Power Generating Capacity** (gigawatts/1,000 workers)	**839**	**0.12**	**1.54**	**78.67/21.33**
5	**Log Initial Income**	**832**	**6.86**	**-2.47**	**9.62/90.38**
6	**Population growth (15-64)**	**828**	**0.2**	**2.37**	**85.75/14.25**
7	**Oil Rich or Not**	**740**	**0**	**2.36**	**78.65/21.35**
8	**Years of Schooling**	**736**	**3.21**	**2.02**	**89.95/10.05**
9	**Inflation**	**617**	**12.83%**	**-2.21**	**15.24/84.76**
10	**Government Debt Share**	**603**	**41.82%**	**-1.72**	**5.14/94.86**
11	Global Growth Rate	571	2%	0.84	71.98/28.02
12	Log Conflicts Index	507	5.5	-1.12	30.97/69.03
13	Political Constraints	480	0.12	1.62	78.96/21.04
14	Railway (km/1,000 workers)	294	0.39	0.29	53.06/46.94
15	Trade Share	282	60.44%	-0.92	20.21/79.79
16	No. of Crises	278	3	-1.39	24.82/75.18

Middle-Income					
Rank	Factors	Total Frequency	Average Split Value	Difference of growth between nodes with higher/low value than the splitting value (decade growth rate)	Frequencies of positive contributions / negative contributions (in %)
(1)	(2)	(3)	(4)	(5)	(6)
1	**Population share (15–64)**	**2093**	**59.03%**	**2.38**	**96.42/3.58**
2	**Government Debt Share**	**1690**	**38.29%**	**-2.01**	**2.9/97.1**
3	**No. of Crisis**	**1414**	**8**	**-2.02**	**4.03/95.97**
4	**Log Initial Income**	**1152**	**8.51**	**-2.37**	**7.12/92.88**
5	**FDI share**	**1036**	**1.84%**	**2.25**	**91.89/8.11**
6	**Global Growth Rate**	**974**	**2%**	**2.04**	**97.33/2.67**
7	Political Constraints	721	0.28	-0.15	51.87/48.13
8	**Years of Schooling**	**606**	**6.41**	**0.22**	**45.87/54.13**
9	**Inflation**	**603**	**13.98%**	**-0.64**	**32.01/67.99**
10	Population growth (15-64)	505	0.18	-0.98	22.57/77.43
11	Log Conflicts Index	488	5.75	0.58	59.84/40.16
12	Oil Rich or Not	458	0	1.92	89.96/10.04
13	Trade Share	422	62.75%	-1.22	27.49/72.51
14	Power Generating Capacity (gigawatts/1,000 workers)	286	0.8	-0.46	41.96/58.04
15	Paved Road (km/1,000 workers)	256	4.32	1.09	75.39/24.61
16	Railway (km/1,000 workers)	246	0.69	1.19	68.7/31.3

Table 7. Regression-Tree-Simulated Transition Matrix (in %)

	obs. in the group/total obs.	obs. percentage	Extremely low-income	low-income	Lower-middle-income	Upper-Middle-income	high-income	# years for 50% moving up	# years for 90% moving up
Extremely Low-Income Countries									
Progressive	12/82	14.63	17	83	0	0	0	4	13
Near-stagnant	60/82	73.17	85	15	0	0	0	43	142
Regressive	10/82	12.20	100	0	0	0	0	never	never
Low-Income Countries									
Progressive	32/104	30.77	0	38	62	0	0	8	24
Near-stagnant	59/104	56.73	0	92	8	0	0	79	261
Regressive	13/104	12.50	54	46	0	0	0	never	never
Lower-Middle-Income Countries									
Progressive	43/86	50.00	0	0	44	56	0	9	29
Near-stagnant	19/86	22.09	0	0	95	5	0	129	426
Regressive	24/86	27.91	0	0	100	0	0	never	never
Upper-Middle-Income Countries									
Progressive	66/97	68.04	0	0	0	65	35	17	54
Near-stagnant	23/97	23.71	0	0	0	96	4	156	518
Regressive	8/97	8.25	0	0	12	88	0	never	never

Figure 1. Income Transition from 1960 to 2011[14]



[14] Some central Asian countries are missing because of data unavailability.

Figure 2. Income Transition from 1960 to 2011 in relative terms to the US

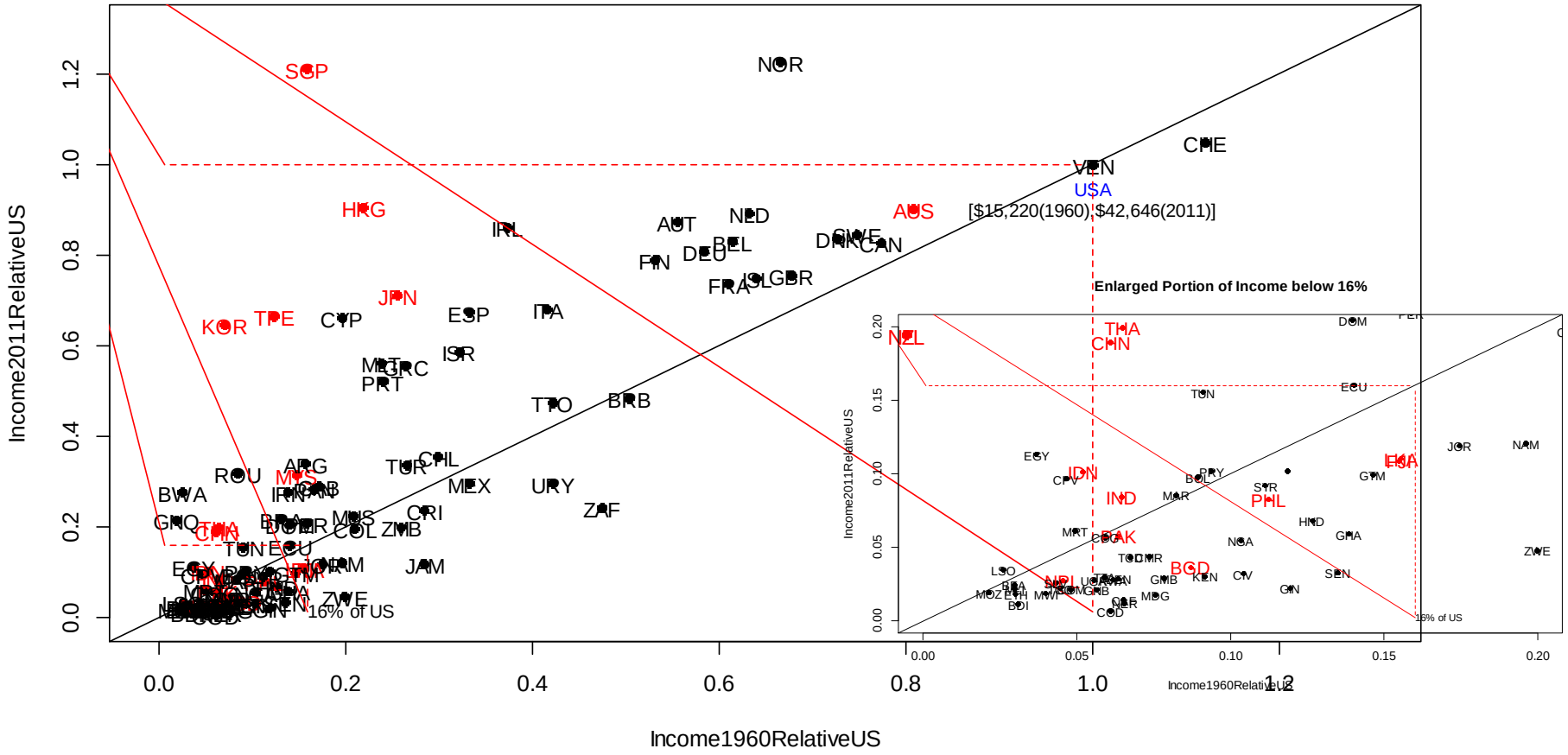
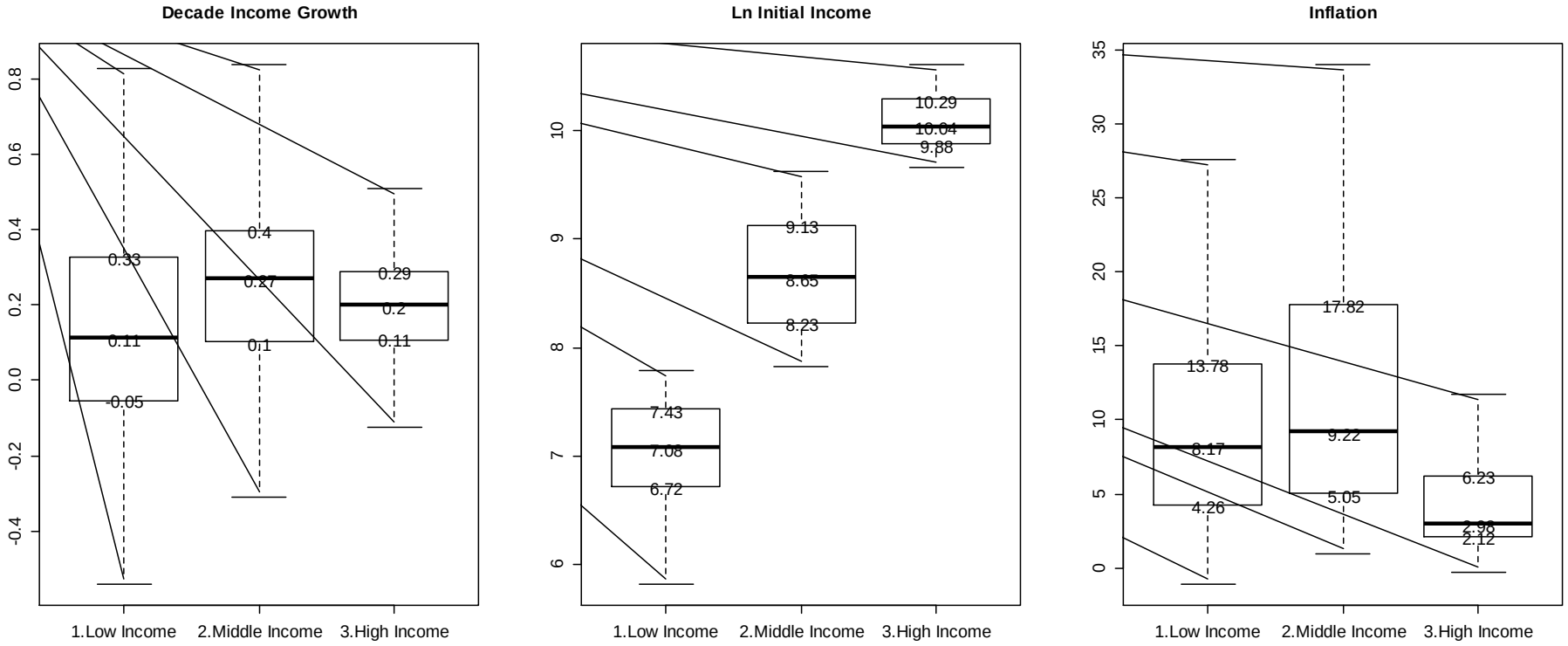
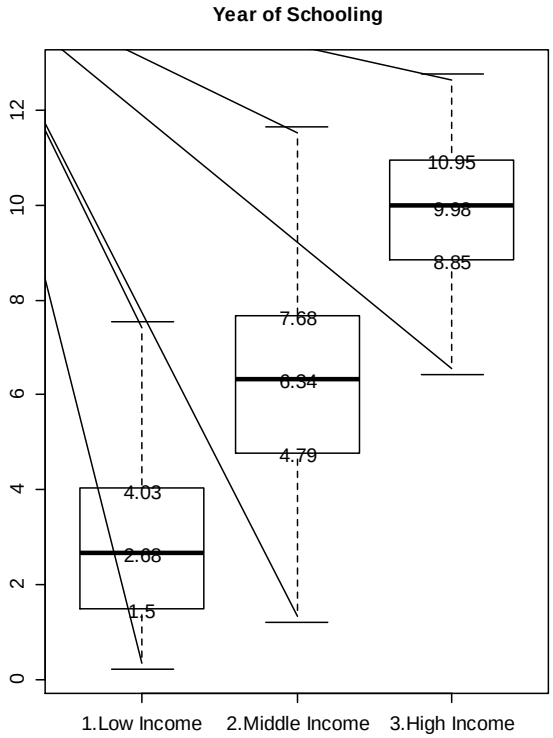
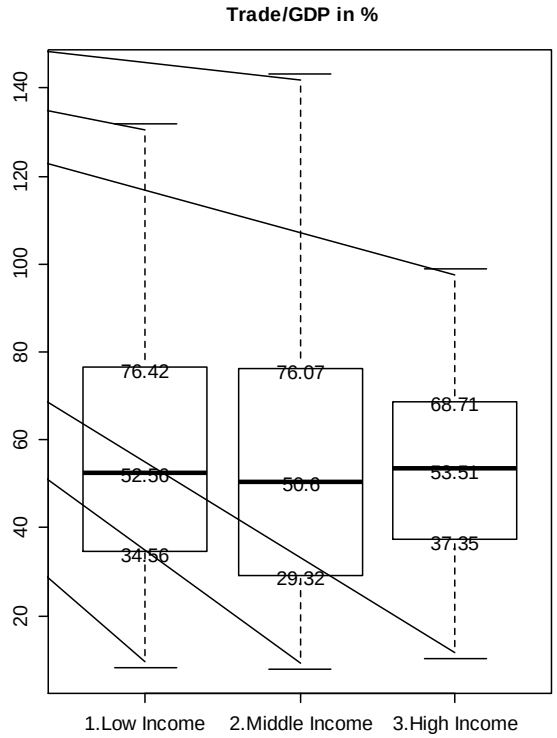
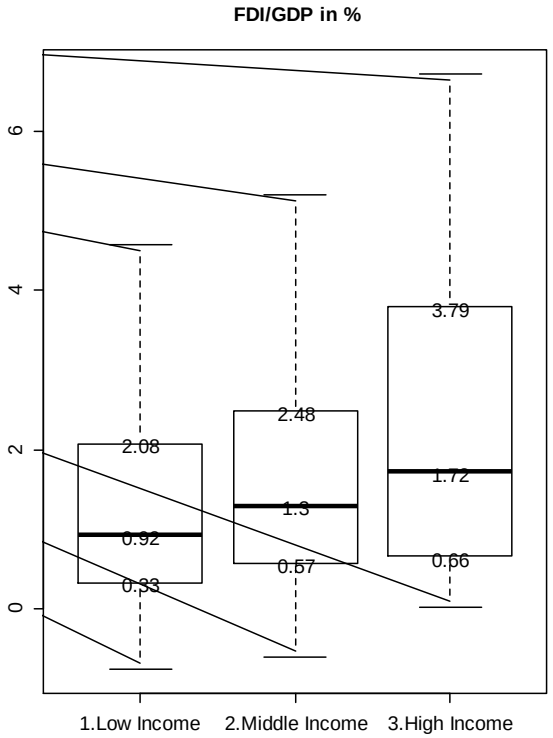


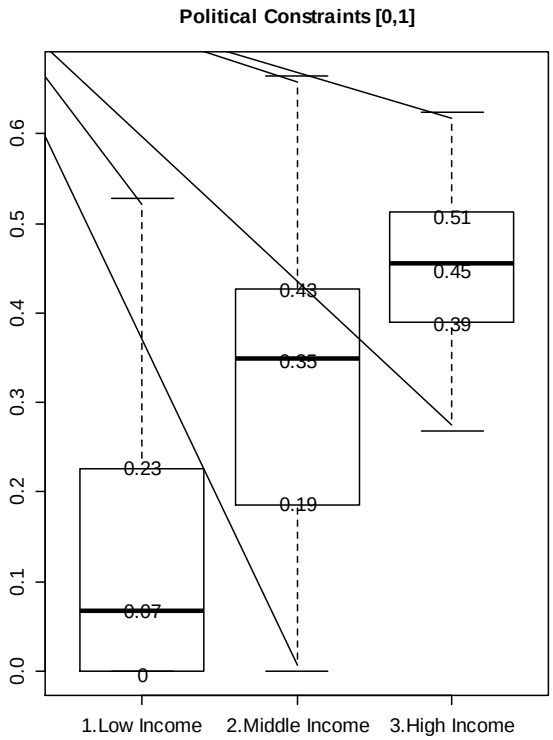
Figure 3. Box Whisker Plot for Variables

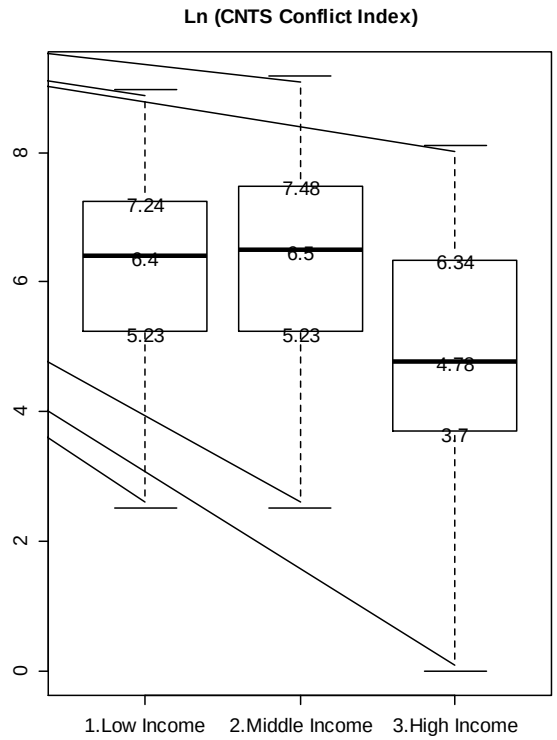


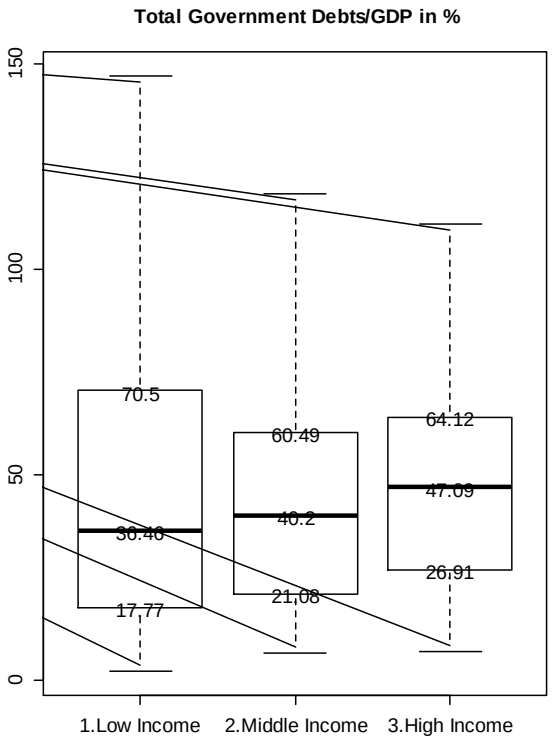

Year of Schooling
0
2
4
6
8
10
12
10.95
9.98
8.85
7.68
6.34
4.79
4.03
2.68
1.5
1.Low Income
2.Middle Income
3.High Income

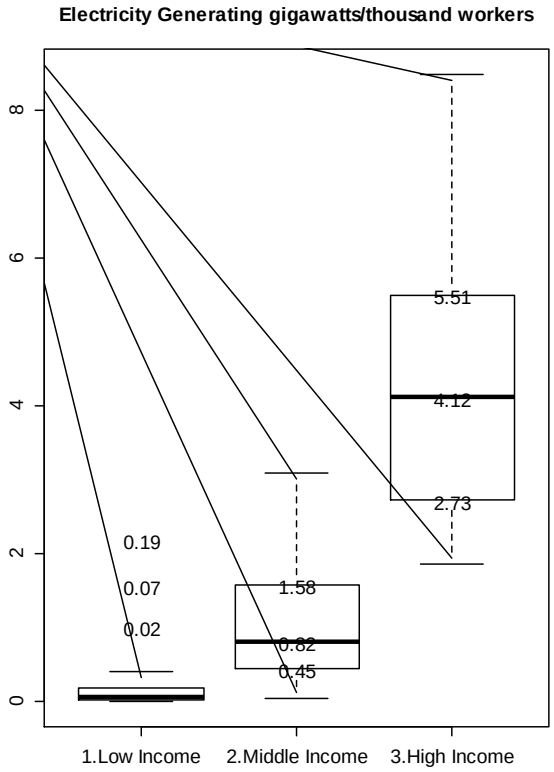

Trade/GDP in %
20
40
60
80
100
120
140
76.42
52.56
34.56
76.07
50.6
29.32
68.71
53.51
37.35
1.Low Income
2.Middle Income
3.High Income

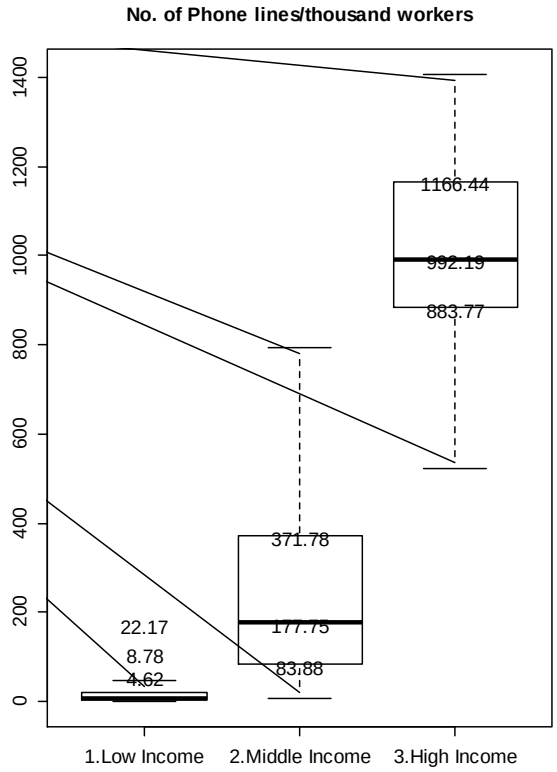

FDI/GDP in %
0
2
4
6
3.79
2.48
2.08
1.72
1.3
0.92
0.66
0.57
0.33
1.Low Income
2.Middle Income
3.High Income

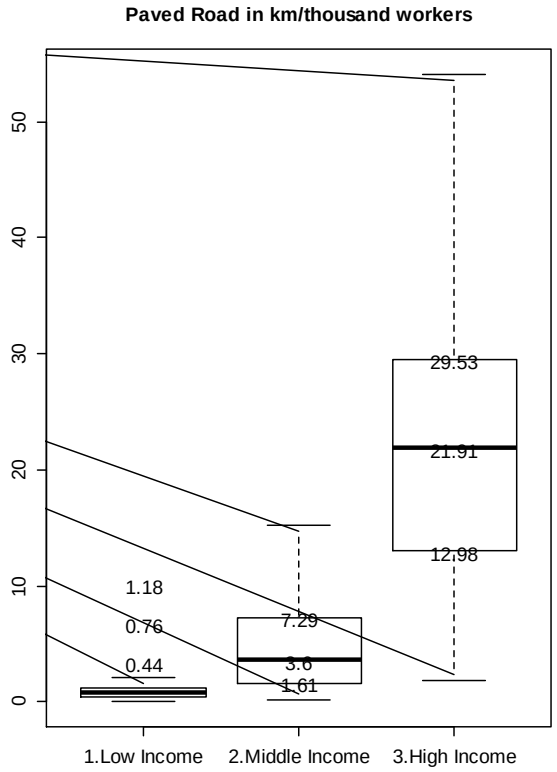

Political Constraints [0,1]
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.23
0.07
0
0.43
0.35
0.19
0.51
0.45
0.39
1.Low Income
2.Middle Income
3.High Income


Ln (CNTS Conflict Index)
0
2
4
6
8
7.24
6.4
5.23
7.48
6.5
5.23
6.34
4.78
3.7
1.Low Income
2.Middle Income
3.High Income


Total Government Debts/GDP in %
0
50
100
150
70.5
36.46
17.77
60.49
40.2
21.08
64.12
47.09
26.91
1.Low Income
2.Middle Income
3.High Income


Electricity Generating gigawatts/thousand workers
0
2
4
6
8
0.19
0.07
0.02
1.58
0.82
0.45
5.51
4.12
2.73
1.Low Income
2.Middle Income
3.High Income


No. of Phone lines/thousand workers
0
200
400
600
800
1000
1200
1400
22.17
8.78
4.62
371.78
177.75
83.88
1166.44
992.19
883.77
1.Low Income
2.Middle Income
3.High Income


Paved Road in km/thousand workers
0
10
20
30
40
50
1.18
0.76
0.44
7.29
3.6
1.61
29.53
21.91
12.98
1.Low Income
2.Middle Income
3.High Income

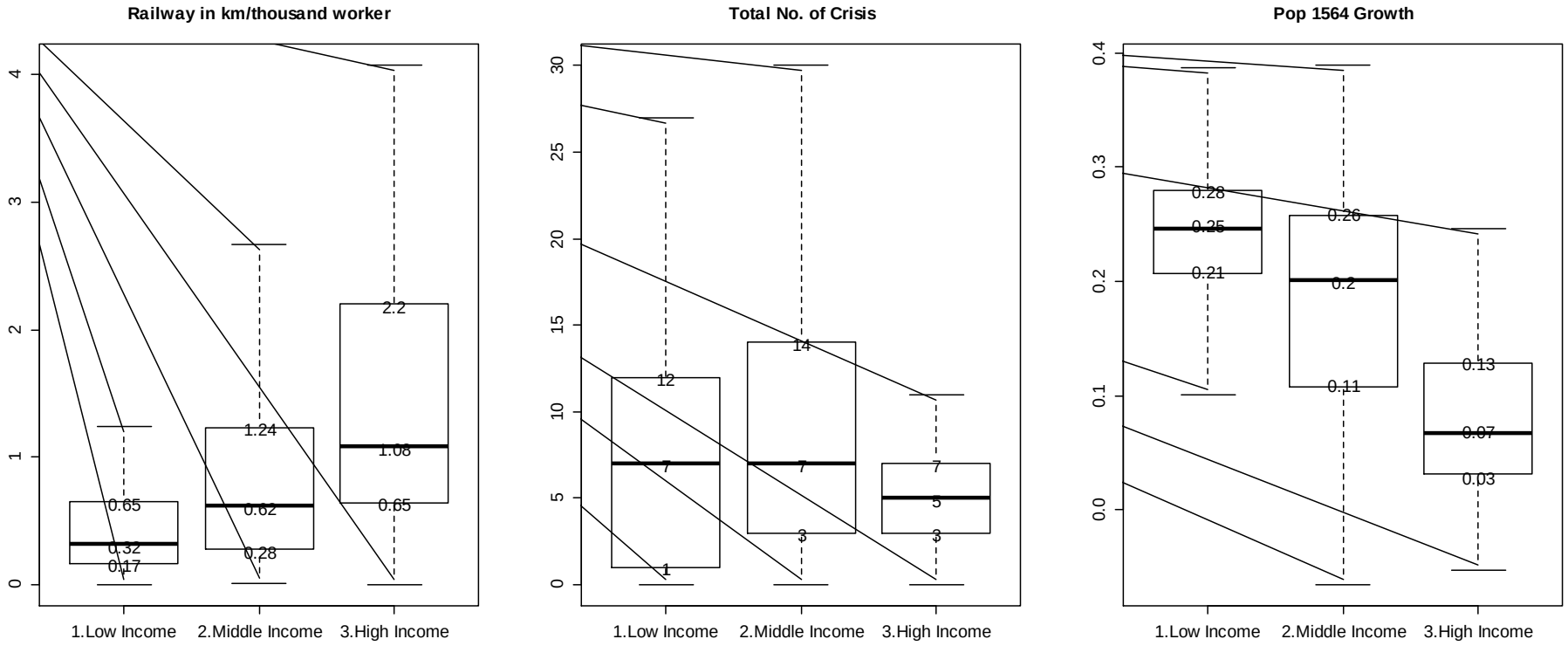
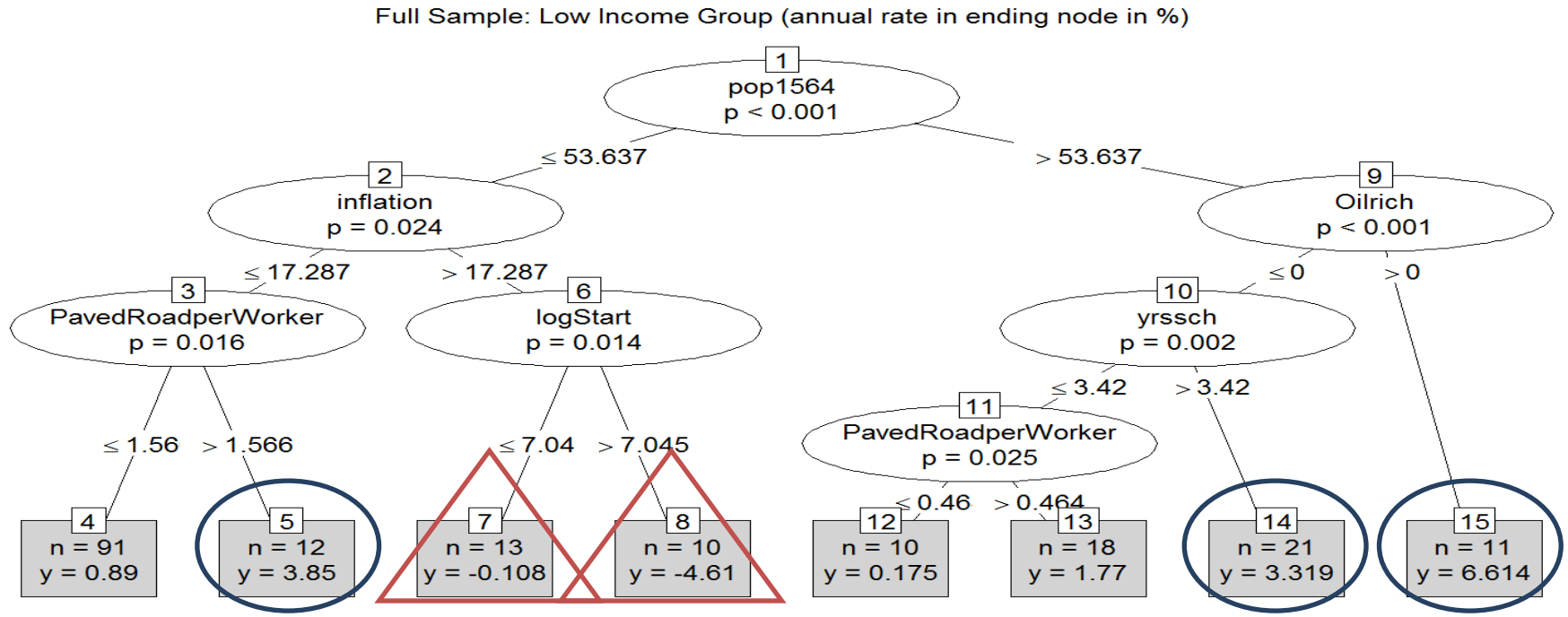
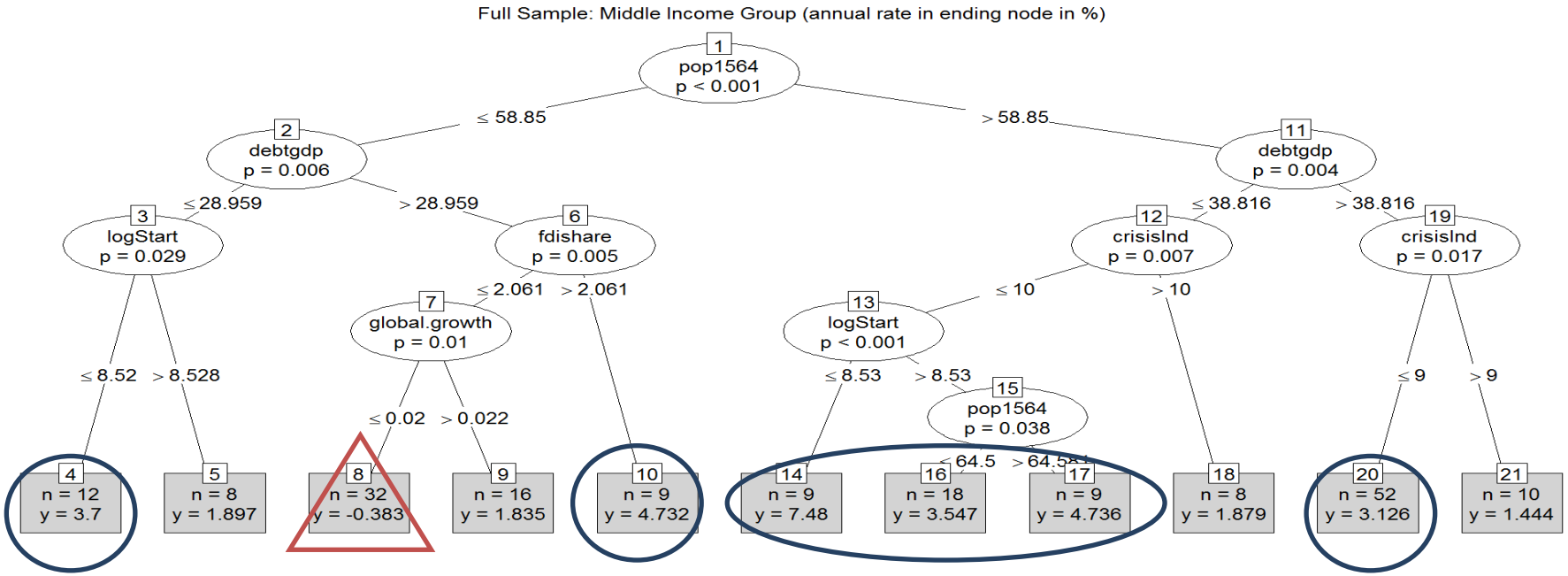

Railway in km/thousand worker
0
1
2
3
4
0.65
0.32
0.17
1.24
0.62
0.28
2.2
1.08
0.65
1.Low Income
2.Middle Income
3.High Income
Total No. of Crisis
0
5
10
15
20
25
30
12
7
1
14
7
3
7
5
3
1.Low Income
2.Middle Income
3.High Income
Pop 1564 Growth
0.0
0.1
0.2
0.3
0.4
0.28
0.25
0.21
0.26
0.2
0.11
0.13
0.07
0.03
1.Low Income
2.Middle Income
3.High Income

Figure 4. Conditional Inference Tree for Low-Income Countries



4	5	7	8	12	13	14	15
Pakistan /1970 (0.01)	Malaysia /1960 (0.020)	Madagascar /1980 (-0.007)	Tanzania /1980 (-0045)	Indonesia /1960 (0.004)	India /1960 (0.022)	India /1990 (0.042)	Indonesia /1970 (0.086)
Honduras /1960 (0.009)	Cape Verde /1980 (0.040)	Tanzania /1990 (-0.01)	Zambia /1990 (-0.03)	Central Africa Rep. /1960 (0.004)	Bolivia /1960 (0.018)	Bolivia /1990 (0.033)	Sudan /2000 (0.052)

Figure 5. Conditional Inference Tree for Middle-Income Countries



4	5	8	9	10	14	16	17	18	20	21
Turkey /1960 (0.035)	Venezuela /1960 (0.019)	Sri Lanka /1970 (-0.045)	Philippines /1990 (0.008)	Malaysia /1970 (0.076)	Greece /1960 (0.079)	France /1970 (0.034)	Portugal /1990 (0.045)	Thailand /1990 (0.035)	Australia /1960 (0.031)	Indonesia /1990 (0.015)
Chili /1960 (0.034)	Turkey /1970 (0.015)	Honduras /1980 (-0.007)	Guatemala /1990 (0.017)	Bolivia /2000 (0.035)	China /2000 (0.081)	Portugal/ 1980 (0.036)	Japan /1970 (0.041)	Mexico /1990 (0.019)	Canada /1960 (0.032)	Greece /1980 (0.017)

Appendix

Table A1. Real GDP per capita in 1960, 1980, and 2011 for Balanced Panel Data for 107 countries

Economy	1960	1980	2011
Argentina	2,383	3,372	14,508
Australia	12,290	19,706	38,499
Austria	8,441	16,625	37,283
Burundi	470	602	490
Belgium	9,338	20,262	35,446
Benin	964	1,175	1,232
Burkina Faso	450	628	1,052
Bangladesh	1,323	1,085	1,554
Bolivia	1,360	1,972	4,167
Brazil	1,982	4,880	9,295
Barbados	7,672	11,653	20,642
Botswana	383	1,988	11,811
Central African Republic	993	719	617
Canada	11,758	22,108	35,345
Switzerland	17,055	26,582	44,824
Chile	4,543	6,370	15,243
China, People's Rep. of	928	1,324	8,069
Cote d`Ivoire	1,584	2,096	1,372
Cameroon	1,117	1,815	1,858
Congo, Dem. Rep.	926	771	291
Congo, Republic of	901	2,052	2,427
Colombia	3,200	6,466	8,408
Comoros	730	1,334	921
Cape Verde	709	943	4,126
Costa Rica	4,314	7,107	10,123
Cyprus	2,989	10,199	28,183
Germany	8,879	17,644	34,520
Denmark	11,050	20,150	35,641
Dominican Republic	2,125	4,122	8,727
Ecuador	2,134	4,616	6,828
Egypt	560	1,068	4,836
Spain	5,066	12,910	28,741
Ethiopia	458	621	783
Finland	8,069	17,220	33,747
Fiji	2,355	4,700	4,645
France	9,274	20,262	31,438
Gabon	2,609	11,876	12,403
United Kingdom	10,313	17,101	32,260
Ghana	2,108	1,637	2,522

Guinea	1,817	2,035	958
Gambia, The	1,192	1,128	1,236
Guinea-Bissau	860	950	907
Equatorial Guinea	285	624	9,176
Greece	4,010	11,881	23,699
Guatemala	2,223	3,603	4,236
Hong Kong,China	3,322	13,154	38,569
Honduras	1,924	2,671	2,920
Indonesia	790	1,887	4,339
India	982	1,075	3,602
Ireland	5,670	11,792	36,705
Iran	2,100	3,546	11,818
Iceland	9,736	24,248	31,922
Israel	4,893	14,207	25,081
Italy	6,323	17,529	29,089
Jamaica	4,316	3,759	5,078
Jordan	2,652	4,061	5,092
Japan	3,889	17,075	30,427
Kenya	1,396	1,667	1,298
Korea, Republic of	1,074	4,340	27,522
Sri Lanka	2,365	1,623	4,701
Lesotho	396	790	1,488
Luxembourg	16,605	26,439	78,131
Morocco	1,249	2,364	3,647
Madagascar	1,149	989	759
Mexico	5,054	10,645	12,710
Mali	450	466	941
Malta	3,623	8,530	23,993
Mozambique	323	469	818
Mauritania	751	1,593	2,616
Mauritius	3,178	4,759	9,645
Malawi	604	767	802
Malaysia	2,252	5,700	13,469
Namibia	2,982	4,920	5,146
Niger	995	1,022	523
Nigeria	1,573	1,857	2,339
Netherlands	9,615	19,658	38,055
Norway	10,126	21,732	52,415
Nepal	690	692	1,185
New Zealand	12,184	14,965	26,667
Pakistan	965	1,613	2,473
Panama	2,514	5,662	12,155
Peru	2,416	3,677	8,924
Philippines	1,708	2,757	3,521

Portugal	3,657	8,935	22,290
Paraguay	1,426	3,021	4,351
Romania	1,276	5,586	13,574
Rwanda	940	1,104	1,201
Senegal	2,052	1,489	1,412
Singapore	2,413	11,147	51,644
El Salvador	655	905	1,117
Sweden	11,377	18,391	36,101
Syria	1,692	2,394	3,919
Chad	1,028	724	1,851
Togo	676	1,215	947
Thailand	986	2,840	8,491
Trinidad & Tobago	6,422	21,266	20,196
Tunisia	1,381	3,719	6,632
Turkey	4,055	6,637	14,437
Taipei,China	1,881	7,782	28,414
Tanzania	899	1,322	1,269
Uganda	844	573	1,187
Uruguay	6,411	8,476	12,625
United States	15,220	25,021	42,646
Venezuela	7,224	9,397	10,343
South Africa	3,949	6,597	8,457
Zambia	3,039	1,459	2,052
Zimbabwe	1,805	2,303	4,348

Linkage between our income group classifications and the World Bank's classifications

The World Bank classifies countries according to the following thresholds:
Low-income countries (L): GNI per capita (Atlas method) ≤ $1045
Lower-middle-income countries (LM): $1045 < GNI per capita (Atlas method) ≤ $4125
Upper-middle-income countries (UM): $4125 < GNI per capita (Atlas method) < $12746
High-income countries (H): GNI per capita (Atlas method) ≥ $12746

We use data on GDP per capita in 2005 purchasing power parity (PPP) terms from the Penn World Tables. To make the World Bank thresholds, which are in GNI per capita (Atlas method) terms, compatible with our data in 2005 PPP, we use the ratios of the average GNI in Atlas method for 2013 to that in 2005 PPP per country group (i.e., L, LM, UM, H) and apply them to the thresholds in GNI Atlas method to get the equivalent thresholds in 2005 PPP.

	Atlas method (2013 US dollars)	PPP (2013 international dollars)	PPP (2005 international dollars)
L	664	1,780	1,536
LM	2,068	5,970	5,152
HM	7,540	13,318	11,494
H	39,312	40,324	34,800

Sources: World Bank country classification; World Bank World Development Indicators (downloaded 29 August 2014).

The resulting thresholds in 2005 PPP are as follows:
L: GNI per capita (2005 PPP) ≤ $2,418
LM: $2418 < GNI per capita (2005 PPP) ≤ $10,276
UM: $10276 < GNI per capita (2005 PPP) < $19,429
H: GNI per capita (2005 PPP) ≥ $19,429

However, using the revised thresholds, the US would be classified only as a middle-income country in 1960. As this appears to be too strict, an adjustment was effected to make the US income as the threshold for classifying high-income countries. In addition, another category was included, extremely low-income countries, which comprise countries with per capita income below $3/day in 2005 PPP or $1,096/year in 2005 PPP terms. Furthermore, the threshold for lower- and upper-middle-income countries was also calibrated so that there are about the same number of countries in the lower- and upper-middle-income categories in 1960.

The final thresholds used are as follows:
Extremely low-income countries: GNI per capita (2005 PPP) ≤ $1,096
Low-income countries: $1,096 < GNI per capita (2005 PPP) ≤ $2,418
Lower-middle-income countries: $2418 < GNI per capita (2005 PPP) ≤ $5,500
Upper-middle-income countries: $5,500 < GNI per capita (2005 PPP) < $15,220
High-income countries: GNI per capita (2005 PPP) ≥ $15220

Figure A1. Income Transition from 1980 to 2011

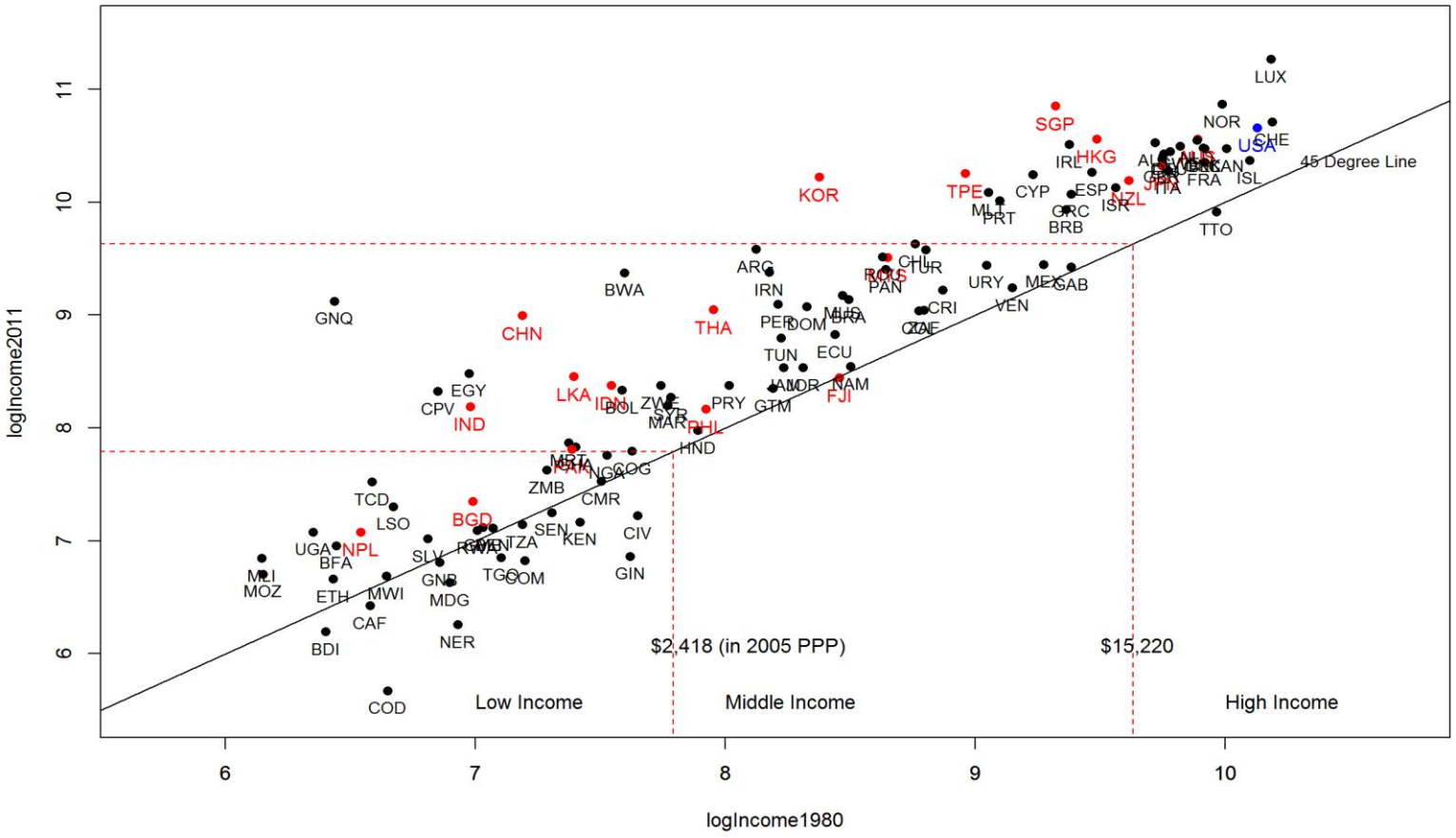


Table A2. Factors included in the Regression Tree Analysis

Indicators	Included in ADB's Eight Key Actions	Included in Washington Consensus	Other important factors for development
1. Political Stability: Domestic conflicts indicator from Cross-National Time-Series database;	✓	✓	
2. Macroeconomic stability: inflation, government debt share, and the number of crisis episodes (currency, banking, and stock market crises);	✓	✓	
3. Investment in infrastructure: paved road, railway, and power generating capacity;			
4. Investment in human capital: average years of schooling from Barro-Lee database;	✓	✓	
5. An open trade and investment regime: trade share and share of net FDI inflow in GDP;	✓	✓	
6. Good governance: political constraints indices by Henisz (2002);			
7. Initial Income level;	✓	✓	✓
8. Demography: share of population aged 15–64 and changes of log (population aged 15–64);	✓	✓	✓
9. Global economic environment: growth rate of the leading economies;			✓
10. Oil rich indicator.			✓

Note: In the eight key actions of ADB, two actions are not covered in our analysis. One is a clear vision for the future since it is hard to find an appropriate indicator. The other is the equality of access to incomes and other opportunities. We have indicators, such as Gini coefficient and share of population with incomes belonging to the bottom 40%, to represent inequality. However, since inequality is more frequently cited as the result of growth rather than the cause, we did not include them in the regression tree analysis.

Table A3. Actual Annual Growth Rate and Predicted Growth Rate for Country-Decades included in the Regression Tree Analysis – Low-Income Countries

Country (1)	Decade Start (2)	Actual Annual Growth (3)	Initial Income (4)	Predicted Growth (5)	End Node Number (6)	Absolute Value of Predicted Error (abs(3-5))
Lesotho	1980	0.009	$790	0.009	4	0.0001
Honduras	1960	0.009	$1,924	0.009	4	0.0003
El Salvador	1970	0.010	$817	0.009	4	0.0014
Congo, Rep.	1990	0.007	$1,689	0.009	4	0.0014
Pakistan	1970	0.011	$1,453	0.009	4	0.0016
Sudan	1970	0.007	$1,010	0.009	4	0.0017
Togo	1970	0.012	$1,082	0.009	4	0.0028
Benin	1990	0.012	$1,045	0.009	4	0.0028
Gambia, The	2000	0.012	$1,169	0.009	4	0.0032
Kenya	1960	0.006	$1,396	0.009	4	0.0034
Kenya	1970	0.012	$1,475	0.009	4	0.0034
Central African Republic	1980	0.005	$719	0.009	4	0.0039
Burundi	2000	0.005	$448	0.009	4	0.0039
Rwanda	1970	0.013	$971	0.009	4	0.0040
Benin	2000	0.004	$1,174	0.009	4	0.0048
Pakistan	1990	0.004	$1,974	0.009	4	0.0050
Niger	1960	0.003	$995	0.009	4	0.0054
Burkina Faso	1990	0.014	$625	0.009	4	0.0055
Rwanda	1960	0.003	$940	0.009	4	0.0057
Gambia, The	1990	0.003	$1,135	0.009	4	0.0059
Mauritania	1990	0.003	$1,340	0.009	4	0.0060
Tanzania	1970	0.003	$1,287	0.009	4	0.0062
Niger	2000	0.003	$514	0.009	4	0.0064
Cameroon	1980	0.016	$1,815	0.009	4	0.0068
Benin	1970	0.002	$1,154	0.009	4	0.0071
Lesotho	1990	0.017	$862	0.009	4	0.0081
Ecuador	1960	0.017	$2,134	0.009	4	0.0084
Burundi	1960	0.017	$470	0.009	4	0.0084
Ghana	1960	0.000	$2,108	0.009	4	0.0086
Burkina Faso	1980	0.000	$628	0.009	4	0.0094
Niger	1970	-0.001	$1,030	0.009	4	0.0097
Malawi	1970	-0.001	$775	0.009	4	0.0099
Mali	2000	0.019	$780	0.009	4	0.0100
Bolivia	1970	0.019	$1,629	0.009	4	0.0104
Philippines	1960	0.020	$1,708	0.009	4	0.0108
Cameroon	2000	-0.002	$1,870	0.009	4	0.0111

Pakistan	1980	0.020	$1,613	0.009	4	0.0115
Kenya	1980	-0.003	$1,667	0.009	4	0.0117
Mali	1990	0.021	$635	0.009	4	0.0119
Rwanda	1980	-0.003	$1,104	0.009	4	0.0121
Mauritania	1970	-0.004	$1,665	0.009	4	0.0133
El Salvador	1960	0.022	$655	0.009	4	0.0134
Cote d'Ivoire	1980	-0.005	$2,096	0.009	4	0.0137
Senegal	2000	-0.005	$1,543	0.009	4	0.0138
Burundi	1980	-0.005	$602	0.009	4	0.0142
Honduras	1970	0.024	$2,109	0.009	4	0.0150
Senegal	1980	0.024	$1,489	0.009	4	0.0152
Paraguay	1960	0.024	$1,426	0.009	4	0.0155
Madagascar	2000	-0.008	$832	0.009	4	0.0169
Guatemala	1960	0.027	$2,223	0.009	4	0.0177
Senegal	1970	-0.009	$1,634	0.009	4	0.0181
Philippines	1970	0.029	$2,076	0.009	4	0.0199
Benin	1980	-0.012	$1,175	0.009	4	0.0206
Cote d'Ivoire	1970	-0.012	$2,363	0.009	4	0.0208
Central African Republic	1990	-0.012	$756	0.009	4	0.0212
Cameroon	1990	-0.012	$2,120	0.009	4	0.0214
Malawi	1980	-0.013	$767	0.009	4	0.0216
Malawi	2000	0.031	$588	0.009	4	0.0217
Liberia	2000	-0.013	$516	0.009	4	0.0218
Uganda	1990	0.031	$625	0.009	4	0.0224
Mali	1980	0.031	$466	0.009	4	0.0225
Liberia	1970	-0.015	$1,596	0.009	4	0.0235
Uganda	2000	0.033	$851	0.009	4	0.0239
Peru	1960	0.033	$2,416	0.009	4	0.0245
Togo	1990	-0.016	$960	0.009	4	0.0251
Niger	1990	-0.017	$609	0.009	4	0.0257
Mauritania	1980	-0.017	$1,593	0.009	4	0.0260
Burkina Faso	2000	0.036	$721	0.009	4	0.0266
Congo, Rep.	1980	-0.019	$2,052	0.009	4	0.0282
Iran, Islamic Rep.	1960	0.037	$2,100	0.009	4	0.0284
Senegal	1990	-0.020	$1,889	0.009	4	0.0289
Cameroon	1970	0.039	$1,234	0.009	4	0.0304
Lesotho	1970	0.039	$537	0.009	4	0.0305
Senegal	1960	-0.023	$2,052	0.009	4	0.0314
Togo	1980	-0.023	$1,215	0.009	4	0.0322
Burundi	1990	-0.024	$571	0.009	4	0.0329
Brazil	1960	0.046	$1,982	0.009	4	0.0374
Madagascar	1970	-0.029	$1,327	0.009	4	0.0379
Tanzania	2000	0.048	$750	0.009	4	0.0391

Togo	1960	0.048	$676	0.009	4	0.0393
Congo, Rep.	1970	0.049	$1,271	0.009	4	0.0402
Paraguay	1970	0.052	$1,815	0.009	4	0.0434
Rwanda	2000	0.053	$677	0.009	4	0.0441
Ethiopia	2000	0.057	$435	0.009	4	0.0478
Rwanda	1990	-0.045	$1,069	0.009	4	0.0536
Mozambique	2000	0.063	$423	0.009	4	0.0541
Niger	1980	-0.050	$1,022	0.009	4	0.0594
Uganda	1970	-0.053	$985	0.009	4	0.0616
Thailand	1960	0.072	$986	0.009	4	0.0634
Mauritania	1960	0.083	$751	0.009	4	0.0740
Liberia	1980	-0.090	$1,378	0.009	4	0.0985
Cape Verde	1980	0.040	$943	0.039	5	0.0011
Morocco	1960	0.044	$1,249	0.039	5	0.0052
Tunisia	1960	0.048	$1,381	0.039	5	0.0092
Zimbabwe	1980	0.050	$2,303	0.039	5	0.0120
Dominican Republic	1960	0.024	$2,125	0.039	5	0.0140
Cape Verde	1990	0.053	$1,391	0.039	5	0.0145
Tunisia	1970	0.054	$2,200	0.039	5	0.0154
Morocco	1970	0.021	$1,915	0.039	5	0.0172
Malaysia	1960	0.020	$2,252	0.039	5	0.0185
Syrian Arab Republic	1990	0.019	$1,051	0.039	5	0.0193
Zimbabwe	1970	0.008	$2,128	0.039	5	0.0306
Zambia	2000	0.081	$946	0.039	5	0.0423
Gambia, The	1980	0.001	$1,128	-0.001	7	0.0017
Nigeria	1990	0.002	$407	-0.001	7	0.0035
Madagascar	1980	-0.007	$989	-0.001	7	0.0056
Sudan	1980	0.006	$1,085	-0.001	7	0.0067
Madagascar	1990	-0.011	$925	-0.001	7	0.0095
Tanzania	1990	-0.011	$836	-0.001	7	0.0097
Uganda	1980	0.009	$573	-0.001	7	0.0098
Malawi	1990	-0.014	$675	-0.001	7	0.0126
Sudan	1990	0.020	$1,147	-0.001	7	0.0211
El Salvador	1980	-0.024	$905	-0.001	7	0.0233
Mozambique	1990	0.023	$336	-0.001	7	0.0244
Sierra Leone	1980	0.024	$1,109	-0.001	7	0.0252
Mozambique	1980	-0.033	$469	-0.001	7	0.0317
Tanzania	1980	-0.045	$1,322	-0.046	8	0.0013
Zambia	1990	-0.030	$1,285	-0.046	8	0.0159
Guinea	2000	-0.027	$1,244	-0.046	8	0.0188
Sierra Leone	1990	-0.065	$1,408	-0.046	8	0.0192
Ghana	1970	-0.025	$2,115	-0.046	8	0.0208

Kenya	1990	-0.019	$1,621	-0.046	8	0.0270
Ghana	1980	-0.017	$1,637	-0.046	8	0.0295
Syrian Arab Republic	1980	-0.079	$2,394	-0.046	8	0.0329
Zambia	1980	-0.013	$1,459	-0.046	8	0.0335
Nigeria	1980	-0.141	$1,857	-0.046	8	0.0947
Mali	1960	0.000	$450	0.002	12	0.0013
Central African Republic	1960	0.004	$993	0.002	12	0.0022
Indonesia	1960	0.004	$790	0.002	12	0.0026
Cameroon	1960	0.010	$1,117	0.002	12	0.0083
Nepal	2000	0.012	$1,036	0.002	12	0.0101
Nepal	1970	-0.009	$754	0.002	12	0.0103
Nepal	1990	0.012	$919	0.002	12	0.0103
Central African Republic	2000	-0.010	$668	0.002	12	0.0116
Nepal	1980	0.029	$692	0.002	12	0.0270
Central African Republic	1970	-0.036	$1,033	0.002	12	0.0373
Bolivia	1960	0.018	$1,360	0.018	13	0.0005
Egypt, Arab Rep.	1970	0.017	$905	0.018	13	0.0010
Sierra Leone	2000	0.016	$717	0.018	13	0.0014
India	1960	0.022	$982	0.018	13	0.0044
India	1980	0.012	$1,075	0.018	13	0.0052
Nigeria	1960	0.009	$1,573	0.018	13	0.0090
Gambia, The	1960	0.006	$1,192	0.018	13	0.0116
Mali	1970	0.003	$452	0.018	13	0.0146
Thailand	1970	0.037	$1,982	0.018	13	0.0189
Morocco	1980	0.038	$2,364	0.018	13	0.0203
Cote d'Ivoire	1960	0.041	$1,584	0.018	13	0.0231
Pakistan	1960	0.042	$965	0.018	13	0.0241
Sierra Leone	1970	-0.006	$1,183	0.018	13	0.0241
Gambia, The	1970	-0.012	$1,267	0.018	13	0.0293
India	1970	-0.013	$1,222	0.018	13	0.0304
Egypt, Arab Rep.	1960	0.049	$560	0.018	13	0.0315
Cote d'Ivoire	1990	-0.018	$1,997	0.018	13	0.0358
Cape Verde	2000	0.057	$2,332	0.018	13	0.0397
Bolivia	1990	0.033	$2,030	0.033	14	0.0000
Lesotho	2000	0.033	$1,020	0.033	14	0.0000
China, People's Rep. of	1970	0.032	$967	0.033	14	0.0013
El Salvador	1990	0.035	$707	0.033	14	0.0015
Ghana	2000	0.035	$1,661	0.033	14	0.0023
India	1990	0.042	$1,217	0.033	14	0.0085

China, People's Rep. of	1980	0.044	$1,324	0.033	14	0.0110
Argentina	1960	0.022	$2,383	0.033	14	0.0116
Sri Lanka	1980	0.047	$1,623	0.033	14	0.0138
Ghana	1990	0.018	$1,385	0.033	14	0.0149
Pakistan	2000	0.017	$2,053	0.033	14	0.0162
El Salvador	2000	0.011	$994	0.033	14	0.0223
China, People's Rep. of	1990	0.056	$2,041	0.033	14	0.0232
Mauritania	2000	0.057	$1,380	0.033	14	0.0234
Togo	2000	0.009	$815	0.033	14	0.0238
Sri Lanka	1960	0.008	$2,365	0.033	14	0.0252
Korea, Rep. of	1960	0.059	$1,074	0.033	14	0.0257
India	2000	0.065	$1,831	0.033	14	0.0317
Kenya	2000	-0.005	$1,337	0.033	14	0.0380
Cote d'Ivoire	2000	-0.007	$1,663	0.033	14	0.0406
Korea, Rep. of	1970	0.086	$1,904	0.033	14	0.0527
Egypt, Arab Rep.	1980	0.055	$1,068	0.066	15	0.0110
Egypt, Arab Rep.	1990	0.080	$1,826	0.066	15	0.0136
Sudan	2000	0.052	$1,399	0.066	15	0.0144
Singapore	1960	0.081	$2,413	0.066	15	0.0149
Indonesia	1970	0.086	$825	0.066	15	0.0201
Indonesia	1980	0.038	$1,887	0.066	15	0.0282
Congo, Rep.	2000	0.027	$1,820	0.066	15	0.0390
Syrian Arab Republic	2000	0.123	$1,271	0.066	15	0.0567
Nigeria	1970	0.008	$1,716	0.066	15	0.0582
Bolivia	1980	0.003	$1,972	0.066	15	0.0632
Nigeria	2000	0.175	$417	0.066	15	0.1087

Table A4. Actual Annual Growth Rate and Predicted Growth Rate for Country-Decades included in the Regression Tree Analysis – Middle-Income Countries

Country (1)	Decade Start (2)	Actual Annual Growth (3)	Initial Income (4)	Predicted Growth (5)	End Node Number (6)	Absolute Value of Predicted Error (abs(3-5))
Turkey	1960	0.035	$4,055	0.037	4	0.0018
Chile	1960	0.034	$4,543	0.037	4	0.0032
Mexico	1960	0.032	$5,054	0.037	4	0.0049
Dominican Republic	1970	0.043	$2,706	0.037	4	0.0060
Brazil	1970	0.046	$3,116	0.037	4	0.0089
Colombia	1970	0.049	$4,025	0.037	4	0.0115
Costa Rica	1960	0.024	$4,314	0.037	4	0.0134
Colombia	1960	0.023	$3,200	0.037	4	0.0138
Guatemala	1970	0.022	$2,889	0.037	4	0.0147
Ecuador	1970	0.062	$2,533	0.037	4	0.0249
Guatemala	2000	0.011	$3,739	0.037	4	0.0255
Panama	1960	0.063	$2,514	0.037	4	0.0260
Venezuela, RB	1960	0.019	$7,224	0.019	5	0.0003
Turkey	1970	0.015	$5,732	0.019	5	0.0042
Venezuela, RB	1970	0.007	$8,745	0.019	5	0.0117
Turkey	1980	0.031	$6,637	0.019	5	0.0122
Chile	1970	0.001	$6,337	0.019	5	0.0184
Iceland	1960	0.040	$9,736	0.019	5	0.0214
Colombia	1980	-0.005	$6,466	0.019	5	0.0245
Mexico	1970	0.044	$6,930	0.019	5	0.0249
Dominican Republic	1980	-0.006	$4,122	-0.004	8	0.0027
Honduras	1980	-0.007	$2,671	-0.004	8	0.0029
Panama	1980	0.000	$5,662	-0.004	8	0.0038
Zimbabwe	2000	-0.008	$4,415	-0.004	8	0.0041
Costa Rica	1980	-0.009	$7,107	-0.004	8	0.0050
Guatemala	1980	-0.013	$3,603	-0.004	8	0.0090
Syrian Arab Republic	1970	-0.014	$2,743	-0.004	8	0.0097
Ecuador	1980	-0.014	$4,616	-0.004	8	0.0100
Paraguay	1980	0.007	$3,021	-0.004	8	0.0113
Mexico	1980	-0.016	$10,645	-0.004	8	0.0117
Brazil	1980	0.008	$4,880	-0.004	8	0.0121
Peru	1980	-0.016	$3,677	-0.004	8	0.0124
Peru	1970	0.009	$3,357	-0.004	8	0.0130
South Africa	1980	-0.018	$6,597	-0.004	8	0.0138

Philippines	1980	0.011	$2,757	-0.004	8	0.0153
Venezuela, RB	1980	-0.019	$9,397	-0.004	8	0.0156
Jamaica	1980	0.012	$3,759	-0.004	8	0.0160
Iran, Islamic Rep.	1970	0.016	$3,028	-0.004	8	0.0197
Jordan	1980	-0.024	$4,061	-0.004	8	0.0206
Panama	1970	0.020	$4,630	-0.004	8	0.0242
South Africa	1970	0.022	$5,312	-0.004	8	0.0257
Mauritius	1970	0.023	$3,806	-0.004	8	0.0264
Iran, Islamic Rep.	1980	-0.031	$3,546	-0.004	8	0.0267
Tunisia	1980	0.024	$3,719	-0.004	8	0.0278
Costa Rica	1970	0.027	$5,447	-0.004	8	0.0308
Israel	1980	0.028	$14,207	-0.004	8	0.0318
Jamaica	1970	-0.037	$5,474	-0.004	8	0.0331
Gabon	1980	-0.042	$11,876	-0.004	8	0.0379
Sri Lanka	1970	-0.045	$2,560	-0.004	8	0.0407
Ireland	1970	0.038	$8,126	-0.004	8	0.0418
Jordan	1970	0.042	$2,702	-0.004	8	0.0454
Zambia	1970	-0.093	$3,874	-0.004	8	0.0892
Mauritius	1960	0.018	$3,178	0.018	9	0.0002
Guatemala	1990	0.017	$3,165	0.018	9	0.0015
Zimbabwe	1990	0.016	$3,769	0.018	9	0.0024
Jamaica	1960	0.024	$4,316	0.018	9	0.0057
Zambia	1960	0.025	$3,039	0.018	9	0.0062
Philippines	1990	0.008	$3,090	0.018	9	0.0105
South Africa	1960	0.030	$3,949	0.018	9	0.0117
Honduras	1990	0.003	$2,496	0.018	9	0.0154
Ecuador	1990	0.003	$4,017	0.018	9	0.0157
Trinidad and Tobago	1960	0.037	$6,422	0.018	9	0.0183
Ireland	1960	0.037	$5,670	0.018	9	0.0183
Jordan	1990	-0.001	$3,172	0.018	9	0.0190
Paraguay	1990	-0.003	$3,255	0.018	9	0.0214
Morocco	1990	-0.005	$3,433	0.018	9	0.0230
Gabon	1990	-0.005	$7,757	0.018	9	0.0237
Iran, Islamic Rep.	1990	0.091	$2,600	0.018	9	0.0725
Dominican Republic	1990	0.045	$3,862	0.047	10	0.0020
Bolivia	2000	0.035	$2,814	0.047	10	0.0123
Gabon	2000	0.064	$7,354	0.047	10	0.0164
Malaysia	1970	0.076	$2,744	0.047	10	0.0285
Jamaica	1990	0.015	$4,241	0.047	10	0.0322

Gabon	1970	0.083	$5,352	0.047	10	0.0356
Honduras	2000	0.011	$2,571	0.047	10	0.0361
Malaysia	1980	0.009	$5,700	0.047	10	0.0381
Trinidad and Tobago	1970	0.087	$9,203	0.047	10	0.0400
Greece	1960	0.079	$4,010	0.075	14	0.0043
China, People's Rep. of	2000	0.081	$3,533	0.075	14	0.0059
Argentina	1990	0.083	$4,604	0.075	14	0.0077
Spain	1960	0.065	$5,066	0.075	14	0.0094
Portugal	1960	0.064	$3,657	0.075	14	0.0107
Peru	2000	0.063	$4,484	0.075	14	0.0116
Korea, Rep. of	1980	0.094	$4,340	0.075	14	0.0194
Japan	1960	0.114	$3,889	0.075	14	0.0392
Paraguay	2000	0.030	$3,156	0.075	14	0.0450
Dominican Republic	2000	0.036	$6,018	0.035	16	0.0007
Portugal	1980	0.036	$8,935	0.035	16	0.0008
Chile	1990	0.034	$6,770	0.035	16	0.0014
France	1970	0.034	$14,513	0.035	16	0.0015
Greece	1970	0.033	$8,588	0.035	16	0.0025
Norway	1970	0.038	$14,900	0.035	16	0.0030
Austria	1960	0.039	$8,441	0.035	16	0.0038
Norway	1960	0.039	$10,126	0.035	16	0.0039
South Africa	2000	0.031	$5,914	0.035	16	0.0040
Spain	1970	0.031	$9,549	0.035	16	0.0049
Austria	1970	0.030	$12,407	0.035	16	0.0058
Portugal	1970	0.028	$6,807	0.035	16	0.0079
France	1960	0.046	$9,274	0.035	16	0.0103
Venezuela, RB	2000	0.048	$6,170	0.035	16	0.0128
Finland	1960	0.050	$8,069	0.035	16	0.0142
Spain	1980	0.019	$12,910	0.035	16	0.0162
Iceland	1970	0.053	$14,467	0.035	16	0.0175
Mexico	2000	0.013	$10,944	0.035	16	0.0229
Portugal	1990	0.045	$12,756	0.047	17	0.0023
Denmark	1960	0.044	$11,050	0.047	17	0.0035
Chile	2000	0.043	$9,468	0.047	17	0.0043
Japan	1970	0.041	$11,451	0.047	17	0.0066
Italy	1960	0.058	$6,323	0.047	17	0.0104
Thailand	2000	0.034	$6,184	0.047	17	0.0135
Korea, Rep. of	1990	0.063	$10,679	0.047	17	0.0152
Finland	1970	0.028	$13,099	0.047	17	0.0196
Romania	2000	0.071	$6,633	0.047	17	0.0241
Uruguay	1970	0.019	$7,049	0.019	18	0.0002

Mexico	1990	0.019	$9,102	0.019	18	0.0002
Argentina	1970	0.013	$2,951	0.019	18	0.0054
Turkey	1990	0.013	$9,021	0.019	18	0.0058
Romania	1990	0.009	$6,057	0.019	18	0.0097
Thailand	1990	0.035	$4,392	0.019	18	0.0160
Colombia	1990	-0.002	$6,120	0.019	18	0.0205
Thailand	1980	0.045	$2,840	0.019	18	0.0258
Australia	1960	0.031	$12,290	0.031	20	0.0002
Canada	1960	0.032	$11,758	0.031	20	0.0004
Hungary	2000	0.032	$13,727	0.031	20	0.0005
Turkey	2000	0.030	$10,262	0.031	20	0.0009
United States	1960	0.030	$15,220	0.031	20	0.0011
Ireland	1980	0.032	$11,792	0.031	20	0.0012
Sri Lanka	2000	0.033	$3,178	0.031	20	0.0014
Panama	1990	0.033	$5,661	0.031	20	0.0016
Tunisia	1990	0.030	$4,713	0.031	20	0.0017
Netherlands	1970	0.028	$14,861	0.031	20	0.0029
Malaysia	2000	0.028	$9,866	0.031	20	0.0032
United Kingdom	1970	0.028	$13,005	0.031	20	0.0035
Argentina	2000	0.028	$10,176	0.031	20	0.0037
Costa Rica	1990	0.027	$6,507	0.031	20	0.0047
Colombia	2000	0.026	$6,014	0.031	20	0.0049
Peru	1990	0.037	$3,123	0.031	20	0.0056
Mauritius	1990	0.025	$8,194	0.031	20	0.0063
Indonesia	2000	0.025	$3,181	0.031	20	0.0065
Panama	2000	0.038	$7,820	0.031	20	0.0066
Sweden	1960	0.038	$11,377	0.031	20	0.0067
United Kingdom	1960	0.023	$10,313	0.031	20	0.0078
New Zealand	1980	0.023	$14,965	0.031	20	0.0088
Uruguay	2000	0.022	$9,591	0.031	20	0.0094
Sri Lanka	1990	0.022	$2,569	0.031	20	0.0098
Hungary	1980	0.020	$9,239	0.031	20	0.0108
Israel	1970	0.019	$11,729	0.031	20	0.0119
Egypt, Arab Rep.	2000	0.018	$3,931	0.031	20	0.0131
Brazil	2000	0.018	$7,528	0.031	20	0.0132
Netherlands	1960	0.045	$9,615	0.031	20	0.0132
Uruguay	1990	0.018	$8,035	0.031	20	0.0134
Costa Rica	2000	0.017	$8,458	0.031	20	0.0148
Ecuador	2000	0.047	$4,125	0.031	20	0.0153
Malaysia	1990	0.047	$6,251	0.031	20	0.0154
Italy	1970	0.047	$11,090	0.031	20	0.0156
New Zealand	1960	0.015	$12,184	0.031	20	0.0161
Singapore	1980	0.051	$11,147	0.031	20	0.0197

Jordan	2000	0.053	$3,152	0.031	20	0.0216
Morocco	2000	0.009	$3,278	0.031	20	0.0225
Tunisia	2000	0.008	$6,306	0.031	20	0.0232
Trinidad and Tobago	2000	0.055	$10,878	0.031	20	0.0236
South Africa	1990	0.007	$5,520	0.031	20	0.0243
Mauritius	1980	0.056	$4,759	0.031	20	0.0246
Trinidad and Tobago	1990	0.006	$10,291	0.031	20	0.0257
New Zealand	1970	0.006	$14,158	0.031	20	0.0257
Philippines	2000	0.003	$3,340	0.031	20	0.0280
Jamaica	2000	0.003	$4,929	0.031	20	0.0286
Iran, Islamic Rep.	2000	0.063	$6,202	0.031	20	0.0315
Hungary	1970	0.065	$4,940	0.031	20	0.0334
Mauritius	2000	-0.011	$10,486	0.031	20	0.0419
Gabon	1960	0.074	$2,609	0.031	20	0.0432
Singapore	1970	0.078	$5,262	0.031	20	0.0467
Israel	1960	0.091	$4,893	0.031	20	0.0601
Indonesia	1990	0.015	$2,738	0.014	21	0.0007
Greece	1980	0.017	$11,881	0.014	21	0.0028
Uruguay	1960	0.010	$6,411	0.014	21	0.0049
Hungary	1990	0.020	$11,314	0.014	21	0.0051
Chile	1980	0.006	$6,370	0.014	21	0.0083
Argentina	1980	0.032	$3,372	0.014	21	0.0172
Uruguay	1980	-0.005	$8,476	0.014	21	0.0198
Brazil	1990	0.036	$5,297	0.014	21	0.0213
Greece	1990	0.037	$14,099	0.014	21	0.0225
Venezuela, RB	1990	-0.022	$7,721	0.014	21	0.0366

Extended Discussion on Transition Matrix

Extension 1 Transition trend based on decade-specific transition matrix

Looking at the probability of transition from one income group to the next level in each of the corresponding decades is another way of examining the transition trends. We examine the transition matrix for each decade and find that: (1) the probabilities for the extremely low-income to stay in extremely low-income decreased sharply for the decade 2000–2010 while there was no clear increasing or decreasing trends for the probabilities for low-income to stay in low-income, but also with a peak value for the decade 1990–2000; (2) for decades 1970–1980, 1980–1990, and 1990–2000, the probabilities for the extremely low-income to stay in extremely low-income are higher than those for the low-income to stay in low-income level; (3) the probabilities of the low-income falling back to extremely low-income were lower in the decade 1990–2000/2000–2010 than in the decade 1970–1980/1980–1990; and (4) in terms of moving up to the next higher-income level, decade 2000–2010 is the best decade for extremely low-income to low-income, while decade 1960–1970 is the best for low-income to move up to lower-middle-income with the decade 2000–2010 as the second best. The decade 1980–1990 stands out as one with the least probability for countries in the lower-middle-income (LM) group to move up to upper-middle-income (UM) status, followed by decade 2000–2010, for which decade, the upper-middle-income had the highest probability of remaining in the same group. For lower-middle-income countries, decade 1980–1990 is the hardest decade to move up while for upper-middle-income countries, decade 2000–2010 is the hardest.

Given the very low probability for upper-middle-income countries to move up to the high-income group in decade 2000–2010, it will take 15 decades for 50% of them to become high-income countries. Take note that this transition estimate is only for 50% of those countries. Meanwhile, the transition durations for the extremely low-income and low-income for decade 2000–2010 were short compared with the other decades. Moving from extremely low-income to low-income takes 2 decades, while moving from low-income to lower-middle-income group takes 3 decades.

Extension 2 Effects of Financial Crisis

One possible reason that led to a longer transition duration (15 decades) for upper-middle-income countries to move up to the high-income group was the 2008 financial crisis. To isolate the effect of the 2008 financial crisis, we construct a transition matrix for 2000–2007 and another transition matrix for 2007–2010. The probability of transition from extremely low to low-income and low-income to middle-income group are relatively closer between the two transition matrices than those from the middle-income to high-income group. For the period 2007–2010, the probability for upper-middle-income countries to stay in the same income level is 1. The same period also shows a 0.04 probability for a high-income country to fall back to upper-middle-income status. To make the two transition matrices

comparable, we simulate simulated 21-year duration matrices based on these two implied growth rates. Interestingly, with the 2007–2010 period implied growth rate, the extremely low-income experienced higher growth rate than that implied by the 2000–2007 period, i.e. 0.21 probability to stay in the same income group with the crisis-period implied growth rate compared to 0.41 probability to stay in the same income group for the 2007–2010 period implied growth rate. However, the upper-middle-income and high-income groups experienced much slower growth rates. The resulting probability of 1 for upper-middle-income countries staying put even for the transition matrix with duration of 21 years is because of the implied assumption that in the 21 years, growth performance of all countries takes the same speed as in 2007–2010. As suggested by the above-mentioned results, the 2008 financial crisis damaged the growth speeds of middle-income countries much more severely. The growth progress of low-income countries was "immune" to this crisis.