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RE-EXAMINING THE MIDDLE INCOME TRAP HYPOTHESIS: WHAT TO REJECT AND WHAT TO REVIVE?[†]

Abstract

Do middle-income countries face difficult challenges producing consistent growth? Using transition matrix analysis, we can easily reject any unconditional notion of a "middle-income trap" in the data. However, countries have different fundamentals and policies. Using a non-parametric classification technique, we search for variables that separate fast- and slow-growing countries. For middle-income countries, a relatively large working age population, sex ratio imbalance, macroeconomic stability, and financial development appear to be the key discriminatory variables. We do the same exercise for low-income countries. This framework yields conditions under which countries in the low- and middle-income ranges are trapped or even move backward.

JEL Classification: C14, C30, F01, O11 and O43
Keywords: low-income trap, middle-income trap, regression tree and sex ratio imbalance

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1. Introduction

Are low-income countries likely stuck in a poverty trap? Are middle-income countries likely stuck where they are, 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 sufficiently high growth rates to join the high-income group. For example, Eichengreen et al. (2013) documented that 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. Robertson and Ye (2013) showed that a middle-income country's per capita income relative to the reference country tends to lie within a band. Aiyar et al. (2013) reported that a typical country in the middle-income group has a higher frequency of negative deviations from the growth path compared with countries in the other two groups.

If one follows a dictionary definition of a trap as a situation from which it is difficult or unable to exit once a country gets in (Merriam-Webster Dictionary and Oxford Dictionary), 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 the average or median rate of the middle-income group will clearly and surely become a high-income country, reaching and surpassing the living standard in today's United States (US) or France. In other words, in the data, a typical middle-income country is not expected to be stuck or trapped in 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 contemporaneously 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 ones to discover these patterns in the literature. For example, 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. Felipe et al. (2014) distinguished economies by fast and slow transitions from middle- to high-income group. They argued that the reason people talk about the middle-income trap is because a very small group of countries made these transitions very fast, which are historical outliers rather than the norm. Bulman et al. (2014) documented the evidence against the existence of a middle income trap. After examining the growth rate of countries across different income levels, they did not find stagnations at a particular income level.

Of course, countries in a given income group differ in their fundamentals and policy choices; so also would their growth performances differ. To understand the roles of these fundamentals and policies, in the second part, we introduce a non-parametric classification technique (conditional inference regression tree and random forest) and examine which proposed determinants are most relevant in separating fast- and slow-growing economies, and how these separating variables may differ across income groups. Based on the conditioning variables, we can classify all middle-income countries into three groups: progressive, near-stagnant, and regressive countries. In other words, we can now identify conditions under which middle-income countries can be trapped in their income status or even move backward. We find that demographics (the growth rate of the working age cohort and the sex ratio), infrastructure, macroeconomic management, and openness to FDI are especially important for growth. However, their relationship to growth is not linear. Different clusters of fundamentals and policy choices produce different growth performance. We can do the same for low-income countries using the same methodology.

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 et al. (2013); Felipe et al. (2014); 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 a 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 et al. (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. Using income relative to US,[1] Jones (2015) calculated the long-run stable probability for each income group, which is consistent with our findings. Jones (2015) also touched upon the importance of institutions and governance on economic growth by relying on selected previous literature using a "natural experiment" environment. We will let institutions be one of the fundamental variables in our regression analysis.

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 provides a counterfactual growth scenario analysis; 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 economies in 1960, 1980, and 2011.[2] We categorize all countries into five income groups: "Extremely Low-Income" (ELI) with real GDP per capita less than or equal to $1,096; "Low-Income" (LI) with real GDP per capita of $1,096–$2,418; "Lower-Middle-Income" (LMI) with GDP per capita of $2,418–$5,550; "Upper-Middle-Income" (UMI) with GDP per capita of $5,550–$15,220; and "High-Income" (HI) with GDP per capita greater than or equal to $15,220. The threshold of $2,418 is equivalent to the World Bank's cut-off line between low-income and middle-income countries. In addition, another category was added, extremely low-income countries, which comprises 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.[3] 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 of 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

[1] Less than 5 percent, between 5 and 10 percent, between 10 and 20 percent, between 20 and 40 percent, between 40 and 80 percent, and more than 80 percent.
[2] 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.
[3] This is lower than the World Bank's threshold for high income countries ($19,429), since using the World Bank's threshold would result in the US being classified only as a middle-income country in 1960.

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 economies (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.[4] The threshold for separating upper-middle-income and high-income countries is the 1960 US income level (100%).

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 GDP 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

[4] $2,418/$15,220.

compute the probabilities that a typical country moves to each of the possible income groups over a decade. These probabilities are summarized by a transition matrix in Table 1.[5]

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 has an 82% probability of remaining in the same income status after a decade, and the second cell says it has an 18% probability of becoming a low-income country 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 has a 70% probability of staying in the same income status and 30% probability of moving up as high-income country 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.[6] 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).[7] 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 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,

[5] The decade average transition matrix is estimated based on the 5-decade transition matrices from 1960 to 2010 by employing a numerical 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.

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

[7] 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.

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 have extended this discussion to consider: (i) the transition trend based on decade-specific transition matrices, and (ii) the effect of financial crisis. The qualitative results stay the same. The details 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 (which is a moving target). 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 income as upper-middle-income, and 75% of US income and above as high-income indicating catch up with the US.[8]

Table 3 presents the decade average transition matrix relative to US income from 1960 to 2010. For the low-income group, the probability of entering the 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%[9] 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);[10] lower-middle-income ($1,813–$4,078); upper-middle-income ($4,079–$11,327); and high-income ($11,328 and above).

[8] 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.

[9] 100% of the US income used as the high income cut-off line is consistent with the analysis in absolute terms discussed in section 2.1 using the Penn World Table.

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

Table 4 shows the 50-year duration transition matrices for 1850–1900, 1900–1950, and 1950–2000. For each 50-year period, we included countries with available data for both the entry year and exit year. Compared with 1850–1900 and 1950–2000, in 1900–1950, the low-income group and lower-middle-income group had the highest probability of moving on to the next income level or higher. For the period 1950–2000, the probability for lower-middle-income countries of moving to high-income is 37% while the probability for upper-middle-income countries of achieving 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 the high income group is 100%. For some countries, there were income decreases for some sub-periods. For example, the income of Argentina dropped from $8,206[11] in 1980 to $6,433 in 1990. However, when we examine the transition using the longer 50-year duration matrix, it still enjoyed a positive trend with $2,756 for 1900, $4,987 for 1950, and $8,581 for 2000. That is, even with some countries experiencing short-term backward movements in income, in the long run, the ergodic distribution yields the scenario where all groups end up in the high income group for sure.

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

One implicit assumption in the transition matrix analysis is that the 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. Based on this analysis, we will argue that not all middle-income countries are the same. While many are expected to grow fast, others could be near stagnant, and some could even move backward and revert to low-income status. Furthermore, there are identifiable combinations of country characteristics that would place countries into these different buckets (in a probabilistic sense).

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. Some papers, such as Aiyar et al. (2013) and Rudengren et al. (2014), made qualitative arguments about the roles of governance and education in economic growth without providing formal tests or analytical evidence. Many potential determinants of growth could be summarized by the so-called Washington Consensus or, for a more recent rendition, the "eight key actions for development" by Nakao (2014). One potential growth determinant that emerges from a more recent literature is the sex ratio for the pre-marital age cohort, which we will explain below.

[11] In 1990 International Geary-Khamis dollars.

The variable to be explained is growth performance at the country-decade level starting from the 1960s. For most regressors, we look at the values at the beginning of a decade (so that the regressors are pre-determined). Some variables are available for a shorter time span. The regression tree technique can work with an unbalanced panel.

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.

It is important to note that some plausible determinants of growth are not included in the examination here due to measurement issues. For example, political leaders' vision is identified by Nakao (2014) as one of the key growth determinants. However, we are not aware of a reliable data source that measures the quality of leaders' vision across countries or over time. As a result, we have to leave it out of the analysis here.

Initial income level is commonly accepted as a determinant of the growth rate, as it is implied by the Solow growth model and confirmed by a long list of empirical papers (see a summary by Barro and Sala-i-Martin (2004)). Besides the Solow model, the pattern can be also justified by evolving sources of growth as a function of initial income. Low-income countries benefit from adopting existing technologies created in more developed countries and thus enjoy higher growth rates. As they experience productivity advancements, they move closer to the technology frontier and are compelled to innovate rather than to merely imitate, which is harder, and so their growth rates decline. Therefore, in our analysis, we expect countries with higher initial incomes to have lower growth rates, and those with lower initial incomes to have higher growth rates. 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" in growth rates across countries. Real GDP per capita at the beginning of each decade is used as the initial income.

Demographic variables have three broad categories: (a) ratio of the working age cohort in total population, (b) growth rate of the working age cohort, and (c) sex ratio of the pre-marital age cohort. The first two categories have commonly been considered as basic driving factors of economic growth. 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) and Bloom, et al. (2003). 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 at the end and at the beginning of the decade) as two of the demographic variables. Data comes from the World Bank's World Development Indicators (WDI).

The sex ratio for the pre-marital cohort requires some explanation. Wei and Zhang (2011a, 2011b, and 2012) and Du and Wei (2013) suggested marriage market competition as a key motivation for savings, labor supply, and work effort—a higher level of wealth relative to one's competitor in the dating/marriage market gives one an edge in attracting the opposite sex. This is true regardless of the sex ratio. But in cases of a higher male/female ratio in the pre-marital age cohort, a certain fraction of males will not be able to find a girlfriend or wife. The drive to create and accumulate physical wealth becomes stronger. This implies that a higher sex ratio (or, more precisely, deviations from a balanced sex ratio in either direction) tends to be associated with a higher rate of economic growth.

A few points are worth noting. First, the behavior response to a change in the sex ratio can come from parents with unmarried sons, not just the sons themselves. In fact, the response by the parent cohort (with children aged 0–29) is likely to be quantitatively more important than that of the children themselves. Second, even though parents with daughters may view an increase in the sex ratio as a favorable development for their daughters, they may not reduce their work effort or entrepreneurial tendency enough to offset the reactions by parents with sons. Here is the reason. Even though the probability that their daughters will find a husband has increased, they may not want their daughters to find just any husband. The top N best young men are fixed in number; but the top N young men are wealthier with a higher sex ratio than without it. As a result, the reward for the daughters to be matched with the top best men is also higher. So parents with daughters may also need to compete among themselves. Third, even though a higher sex ratio may lead to faster GDP growth, it does not necessarily lead to a higher level of welfare. The extra GDP growth comes from the desire of the parents with sons to use the accumulation of wealth to reduce the probability of their sons becoming involuntary bachelors. Yet, for the society as a whole, the total number of young men who cannot get married is independent of the wealth accumulation. In this sense, the extra sacrifice that the parents have to make to accumulate wealth may lead to a reduction in welfare. (In other words, the extra GDP growth induced by a sex ratio imbalance may be a case of immiserizing growth.)

Wei and Zhang (2011b) provided evidence from the People's Republic of China (PRC). First, families with an unmarried son living a region with a high sex ratio imbalance are more likely to work more days in a year and choose to be an entrepreneur or self-employed. Second, the growth rate in the count of privately owned firms is higher in regions with a stronger sex ratio imbalance. Third, in panel regressions across Chinese provinces from 1990–2010, GDP growth rates tend to be higher in regions with a high sex ratio. Because of this new demographic hypothesis, we include the sex ratio (males/females) for the age cohort of 0 to 29.

Infrastructure is often claimed to be a key input in a country's investment climate. When Prime Minister Modi of India and President Jokowi of Indonesia came to power in 2014, they both stressed investing in infrastructure as a key to lifting 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. The IMF's World Economic Outlook (2014) also found increased public infrastructure investment to raise output in both the short and long term, particularly during periods of economic slack and when investment efficiency is high. Following the recent trend of using direct measures of infrastructure development rather than infrastructure investment (see Egert et al. (2009) and Calderón et al. (2014)), we use the indicators developed by Calderón et al. (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, supported by two types of evidence. The first type is based on empirical analysis. Barro (1991) may be the first to document a positive correlation between growth rate and initial human capital proxied by initial school-enrollment rates for 98 countries during the period 1960–1985; Mankiw et al. (1992) used the percentage of working-age population that is in secondary school to approximate the rate of human-capital accumulation rate in an augmented Solow model and found a significant contribution from human capital to economic growth. Benhabib and Spiegel (1994) explained the positive relationship using an endogenous growth model in which technological progress is a function of human capital. The second group of papers uses a calibration-based development accounting approach. For example, Caselli and Ciccone (2013) computed the increase in output that can be generated by more schooling which they interpret as an upper bound effect. We use years of schooling as a measure of human capital. An important qualification is that such a measure does not fully capture quality of education (Hanushek and Woessmann, 2008). Unfortunately, test scores from internationally comparable tests, a common variable used to adjust for quality, are not available in time series.

For *macroeconomic policy environment*, we include inflation rate, government debt as a share of GDP, and the number of macro or financial crises in a decade. The CPI inflation come from the World Bank's World Development Indicators. The others are derived from Reinhart and Rogoff (2009) and extended using more recent data. The government debt/GDP is the ratio of the gross central government debt to GDP. The total number of crises is the sum of currency crises[12] and banking crises[13] within a decade.

[12] 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).

[13] A banking crisis is defined as a bank run that leads to closure, merger, or takeover by the public sector of one or more financial institutions; and if there are no runs, the closure, merger, 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.

Three dimensions of *economic openness* are considered: the share of exports plus imports in GDP (trade share), the share of gross FDI inflow to GDP, and the share of gross non-FDI inflow to GDP. The trade share is from the World Bank's World Development Indicators. The FDI and non-FDI inflows are from Bluedorn et al. (2013). Gross non-FDI inflow is the sum of gross portfolio equity inflows, portfolio debt inflows, and other inflows.[14] A vast literature confirms a positive association between trade openness and growth, but causality interpretation is more controversial (see Rodgriguez and Rodrik (2001), Frankel and Romer (1999), and Feyrer (2009)). There are several channels for FDI to affect growth, including: inducing a more educated workforce (Borensztein et al. (1998)), improving trade openness (Balasubramanyam et al. (1996)), and improving financial markets (Alfaro et al. (2003)). Forbes and Warnock (2012) argue that compared with net FDI inflows, gross capital inflows and outflows (allowing differentiation between domestic and foreign investors) have more information on crisis and capital flow volatility. We adopt the newly developed approach by including the accumulated share of gross FDI inflows to GDP and accumulated non-FDI inflows in the four years before the decade starts (for example, sum of inflows in 1967–1970 for the decade starting in 1970). Together with other variables, our framework provides an opportunity to revisit these debates.

Financial development has been frequently argued as an important driver for economic growth. For example, Levine (2005) and Demirgüç-Kunt and Levine (2008) concluded that a well-functioning financial system plays an independent role in promoting long-run economic growth. Guided by the length of data availability, we selected four indicators from the Global Financial Development Database constructed by Čihák et al. (2013): (1) the number of commercial bank branches to represent the degree to which individuals and firms can use financial services (a proxy for financial access);[15] (2) private credit to GDP to represent the size of financial institutions and markets (financial depth); (3) lending-deposit rate spread to represent efficiency of financial intermediaries in intermediating resources and facilitating financial transactions (efficiency); and (4) ratio of bank credit to bank deposit, to represent the stability of financial institutions (stability).

The potential importance of *political institutions* in growth is summarized by Glaeser et al. (2004) as follows: with good political institutions (low expropriation risk) 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 et al. (2001, 2002), Easterly and Levine (2003), Dollar and Kraay (2003), and Rodrik et al. (2002). Following this line, we adopt the political constraint indices used by Henisz (2000, 2002), which measures constraints on the executives (the president or the prime minister) from legislative, judicial, or

[14] Gross derivative inflows are excluded from non-FDI inflows because of its limited coverage.
[15] However, since bank branches per 100,000 adults are only available starting 2003, and our regression tree analysis requires the entry value for each decade, we have to drop this variable in our regression tree analysis.

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.

Inequality is considered by Nakao (2014) as a potential drag on growth. The empirical literature on the relationship between inequality and growth produces mixed results. While Forbes (2000) found that, in a panel regression, a rise in inequality tends to be associated with a pickup in the subsequent growth rate, Deininger and Squire (1998) and Barro (2000) find that higher inequality retards growth in poor countries but encourages growth in rich countries. We include the income share held by the bottom 40% people from WDI as a measure of inequality. The closer this share is to 40%, the less inequality there is. This indicator measures the income share directly, and is easier to understand than the standard Gini coefficient. The income share held by the bottom 40% people has been chosen by the World Bank as an official measure of the degree of broadly shared prosperity since 2013 (World Bank, 2013).

The effect of *resource abundance* on growth is controversial. On the one hand, better endowment in natural resources provides more natural wealth to the country. On the other hand, the literature on "Dutch Disease" and "natural resource curse" also suggest mechanisms in which natural resource abundance could derail a country's long term growth by either making the manufacturing sector uncompetitive or by inducing political instability or expropriations. We use an "oil exporter" to denote major oil exporters for those countries whose fuel exports exceed either 40% of their total exports or 15% of their GDP. Data come from the World Bank's World Development Indicators. A given country could be classified as a major oil exporter in one decade but not in the others. Out of 488 country-decade combinations, 36 observations were labeled as oil exporters.

The *global economic environment* is intended to capture the overall trade and investment climate faced by developing countries. We construct an indicator using the US growth rates before 1980 and the population-weighted average growth rates of Japan, Germany, and the US after 1980. The growth rates of the advanced economies, measured this way, are 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.

Altogether we include 22 variables in our regression tree analysis, which are: (1) working-age

population share (15–64 years old), (2) working age population growth (15–64 years old), (3) paved road in km per 1,000 workers, (4) power generating capacity in gigawatts per 1,000 workers, (5) railway in km per 1,000 workers, (6) years of schooling, (7) log transformed initial income level, (8) global growth rate, (9) inflation, (10) percentage of domestic credit to private sector in GDP, (11) bank credit to deposit ratio, (12) bank lending-to-deposit rate spread, (13) number of years with either banking or currency crises in a decade, (14) government debt share in GDP, (15) log transformed conflicts index, (16) political constraints, (17) accumulated FDI inflow in the four years ahead of each decade, (18) accumulated non-FDI inflow in the four years ahead of each decade, (19) trade share in GDP, (20) income share of bottom 40%, (21) sex ratio (male/female) from age 0–29, and (22) an oil exporter dummy.

We use real GDP per capita from the Penn World Table 8.0 to construct economic growth at the country-decade level. To mitigate a possible endogeneity concern, we use initial values of all variables at the beginning of the decade, except for the growth of the 15–64 age cohort, global growth rate, and the frequency of banking or currency crises in a decade. The dataset includes 120 countries and 5 decades. The first decade is 1960–1969. A country-decade is included in the sample if at least 12 variables are available (out of 22 potential predictors). This results in a total of 488 observations.

3.2 Box Whisker Plot and Pair-wise Correlation Analysis

For each income group, a Box Whisker Plot is drawn for each variable and presented in Figure 3. While the middle-income countries have higher median growth rate (annualized over a decade) at 29%, the low-income countries have a lower median growth at 11%, but with larger variations across countries. There are clear strong associations between income levels (low/middle/high) and years of schooling, political constraints, population share of labor-force age, electricity generating capacity, railway, domestic credit to private sector, and sex ratios for age 0–29. On average, higher levels of each factor are associated with a higher average income.

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 accumulated gross FDI inflow and non-FDI inflow shares, the high-income group has the highest median and largest variation. For domestic conflicts, the low-income and middle-income groups face relatively worse situations than the high-income group. For government debt share, the high-income group has the highest median level at around 41%. For the number of years in a decade one country has either currency or banking crises or both, the high-income group and the middle-income group have the same median at 2. For labor force population growth, the low-income group has the highest decade growth rate at 27% while the high-income group has the lowest decade growth at 7%. The high-income group has the highest median of the bank credit to deposit ratio at 107% while the low-income group has the lowest

median. At the opposite end, the low-income group has the highest median of bank lending-deposit rate spread while the high-income group has the lowest median.

The Box Whisker Plots show heterogeneity in variables among different income groups, indirectly supporting the hypothesis that different subsets of factors matter more for growth among countries in different income groups. Based on this hypothesis, we construct the pair-wise correlation matrices for low-income and middle-income countries. In Table 5, the red color highlights the possibility of a strong relationship—correlations between the growth rate and the factors (the first row) which are either higher than 0.20 or lower than –0.20. The second through the last rows show the correlations between factors. The green color suggests a possibly strong relationship—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, inflation, years of schooling, political constraints, share of population 15–64 years old, government debt share, crisis, FDI inflow, non-FDI inflow, and sex ratio of age 0–29 have higher correlations with growth than other factors; and (2) for the middle-income group, years of schooling, income share of bottom 40%, share of population 15–64 years old, government debt share, crisis, growth of population 15–64 years old, gross FDI inflow, and lending-to-deposit rate spread have relatively higher correlations.

The correlations provide some initial hint that conditional on the stage of development, driving factors of economic growth may 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 estimation, especially for linear regression analysis. Below, we employ the technique of Conditional Inference Regression Tree, which finds possible association without imposing linearity and permits interactions among variables that are not pre-specified by the researcher.

3.3 Conditional Regression Tree Analysis

The regression tree analysis is a machine learning method pioneered by Breiman et al. (1984) and refined in the subsequent literature. The general idea of the technique (in the context of growth prediction) can be described in the following way: 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 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 predicted growth for each end node is simply the average of the growth of country-decades falling into that node. Therefore, for prediction purposes, we first determine which ending node a country will be

located based on the values of its fundamentals and then the average growth rate in that ending node is assigned to be the predicted growth for that country.

Durlauf and Johnson (1995) were the first in applying a regression tree approach to economic growth. But they consider only two conditioning variables: initial income and literacy rate. Their key point is that multiple growth regimes are a better characterization of the data than a single regime.

The Conditional Inference Regression Tree, proposed by Hothorn et al. (2006), is a refinement of the Regression Tree Analysis that introduces hypothesis testing in deciding each split. In particular, a split is made if one can reject the null hypothesis 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 Regression 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 of incorrectly rejecting 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 among all the variables. 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 smaller,[16] a minimum number of observations of 8 for each ending node, and a minimum size of 20 in a branch before any split.

Figures 4 and 5 present the conditional regression trees for low-income and middle-income countries, respectively.[17] On a given tree, the variables used for each split and the associated p-values are labeled in each splitting node. For each split, the branch to the right indicates the outcome when the values of the splitting variable are higher than a threshold value of the parent node, while the branch on the left indicates the outcome when the values are lower than the threshold. The ending nodes, shaded in grey, present the predicted growth rate with the relevant combination of variable values, with the number of observations also listed. The predicted growth rates are average annual growth rates in a decade.

[16] The estimation is carried out with the package party() in R.

[17] We skip the investigation of high-income countries so as to focus the analysis on low-income and middle-income countries.

If there is a threshold effect, an advantage of the conditional tree approach is to search for and identify it by hypothesis testing. In comparison, most papers in the existing literature such as Reinhart and Rogoff (2009) pre-impose a particular value of the threshold, which necessarily involve elements of arbitrariness.

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 their growth performance include: demographics (share of population 15–64 years old, growth of population 15–64 years old, and sex ratio of age 0–29), macroeconomic environment (the number of crisis years in a decade and political constraints), and infrastructure (paved road in kilometers per thousand workers).

Based on the ending node results, we further categorize countries into three groups: progressive (with expected annual growth rate higher than 3%), near-stagnant (with expected growth rate between 0 and 3%), and regressive (with expected negative growth rate) countries. For progressive countries, two combinations of variables produce relatively high growth (labeled with blue circles): Conditional on favorable demographics (share of population 15–64 years old higher than 53.4%), if the country has an imbalanced sex ratio of the pre-marriage group (sex ratio of age 0–29 higher than 0.99) and with a labor force population growth in a decade greater than 21.3%, their expected annual growth rate is 4.3%; while if the labor force population growth is not favorable, a higher share of population 15–64 years old (above 57.8%) can yield a growth rate of 3.69%. When the countries have less favorable demographics (share of population 15–64 years old lower than 53.4%), but have a better macroeconomic environment (crisis years lower than 5) and sound infrastructure (paved road higher than 2.26 km per thousand workers), they can expect an annual growth rate of 3.0%.

There are two groups with alarmingly negative expected growth rates (labeled with red triangles). One negative growth rate at –2.9% is featured with unfavorable demographics (share of population 15–64 years old lower than 53.4%) and an unfavorable macroeconomic environment (the number of crisis years in a decade greater than 5); the other negative growth rate of –1.94% shares common features as the above-discussed scenario but with lower political constraints (lower than 0.167) and poor infrastructure (paved road per thousand workers lower than 2.26 kilometers).

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 rates,

ending node predicted annual growth rates, 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 and sex ratio of age 0–29), macroeconomic environment (government debt to GDP ratio, political constraints, and the number of crisis years in the decade), financial development (credit to private sector share), 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 58.5%) and lower initial income (lower than $5,437) can expect an annual growth rate as high as 6.9% when government debt share is lower than 31.8%; or growth rate at 4.9% when government debt share is higher than 31.8%. Countries with higher initial income (higher than $5,437), sex ratio of age 0–29 greater than 1.03, and lower government debt share (lower than 41.5%) can expect to have a growth rate of 4.06%; or if their government debt share is high (higher than 41.5%), but they have very favorable demographics (share of population 15–64 years old higher than 64.4%), then they can achieve a growth rate of 4.08%; while if the sex ratio is lower than 1.03, sound political constraints can help achieve a growth rate of 3.88%. A third group featuring unfavorable demographics (share of population 15–64 years old lower than 58.5%) but low government debt ratio (lower than 55.9%) and few crisis years (less than or equal to 1), can still expect an annual growth rate of 3.6%.

Middle-income countries can also produce their regressive group. In particular, for a combination of unfavorable demographics (share of population 15–64 years lower than 58.5%), relatively high government debt (greater than 55.9% of GDP), and unfavorable financial development (domestic credit to private sector lower than 28.7% of GDP), growth becomes –1.34% 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 (i.e., a growth rate higher than the high-income group), a favorable demographic pattern (a high share of working age population) and prudent macro debt management are helpful. Without a favorable demographic pattern, a prudent macro debt management can still deliver strong growth. In contrast, macroeconomic instability in the form of high government debt and inadequate financial development are likely to lead to anemic or even negative growth rates.

3.4 Robustness Check with Random Forest Analysis

As a non-parametric technique, relative to linear regression analysis, regression tree analysis 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 on the basis of an independently and randomly drawn sub-sample and subject to random errors. Therefore, as the number of trees in the forest increases, the random errors are averaged out by taking the average of the trees in the forest, helping to yield more robust results compared with a single tree based on the whole sample. Since the size of the 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[18] (based on 1000 randomly drawn sub-samples). In defining the parameters to grow the trees, we choose to use the unbiased random forest as suggested by Strobl et al. (2007).[19] For each tree, we require the maximum p-value for a split to be 5%, the minimum size for a split to be 20, the minimum size for the ending node to be 8, 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 population 15–64 years old appears 1178 times in the forest and the average of its split value across all its 1178 appearances is 53.26%. 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

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

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 53.26% has an annual growth rate around 1.82% higher than that of countries with a share lower than 53.26%. 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 500 (out of 1000) or higher. For low-income countries, the share of population 15–64 years old, paved roads, sex ratio of age 0–29, population growth of 15–64 years old, power generating capacity, initial income, inflation, years of schooling, no. of crises, accumulated FDI inflows, and global growth are the important variables. The variables shown in the regression tree for the whole sample such as favorable demographics, good infrastructure, and sound macroeconomic environment are all picked up as important variables by the forest, which suggests robustness of these variables.

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. Conditional on the tree structures in the forest, we consider their contribution in the forest as the "marginal" effect of that variable on growth. The regression tree and the random forest differ in serving policy purposes. For "diagnostic" types of purposes, such as determining what institutional/fundamental combination can help one economy improve its growth (moving from the regressive group to the progressive group), the regression tree is better. For prioritization purposes, the forest is better since it ranks the importance (marginal effect) of each variable.

In our analysis, although the structure of the regression tree is potentially sensitive to changes in the sample as noted by Shmueli et al. (2007), the resulting country groupings in the end nodes are quite stable. Our intuition is that when the factors are close competitors in explaining the growth differentiation between groups (making the splits), the structure of the tree is more sensitive to data changes. For example, when factor A and factor B are equally good in doing the split, either A or B can be chosen to do the split. While the structure of the tree would be different (since one tree would have factor A and the other tree would have factor B), the country groupings in the end nodes would be exactly the same. This may imply a change in perspective in the application of the regression tree. That is, as long as factor A can represent factor B (or vice versa), it does not matter much which one is on the tree to do the split. For example, the years of schooling is a competing factor of sex ratio of age 0–29, however, as shown in the regression tree analysis, sex ratio of age 0–29 outperforms the years of schooling in explaining the growth.

For middle-income countries, variables with frequencies higher than 500 include the share of population 15–64 years old, government debt share, the years of banking or currency crises in a decade, initial income, inflation, years of schooling, sex ratio of age 0–29, political constraints, conflicts index, and credit to deposit ratio. Again, the variables picked up by the forest cover most of 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 1960–1970, 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 eight important variables for low-income countries: among the top eleven variables (with frequencies higher than 500) listed in Table 6, nine appear in the top eleven list for the sub-sample excluding 1960–1970 (no. of crises and FDI inflow are excluded), ten appear in the top eleven list for the sub-sample excluding 1970–1980 (no. of crises is excluded), ten show in the top eleven list for the sub-sample excluding 1980–1990 (no. of crises is excluded), ten appear in the top eleven list for the sub-sample excluding 1990–2000 (FDI inflow is excluded), and eight appear in the top eleven list for the sub-sample excluding 2000–2010 (inflation, no. of crises, and FDI inflow are excluded).

Among the top ten variables (with frequencies higher than 500 and dominating votes for either positive or negative contributions) for middle-income countries listed in Table 6, ten appear in the top ten list for the sub-sample excluding 1960–1970, eight appear in the top ten list for the sub-sample excluding 1970–1980 (credit to deposit ratio and conflicts are excluded), ten 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 (credit to deposit ratio and years of schooling are excluded), and nine appear in the top ten list for the sub-sample excluding 2000–2010 (credit to deposit ratio is excluded).

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.

4. Long-term Income Distributions and Counterfactual Growth Scenario Analysis

In Section 2, we have shown with the ergodic distribution that allowed enough time, every country can reach high-income status (the US 1960 income level) based on the unconditional transition matrix. That is, we assume that every country in each income category will expect to grow at their income-group-specific growth rate. Based on the same assumption and the income distribution as it was in 2010, we use the decade average transition matrix (Table 1) to simulate the income distributions in 50 years and 100 years. As shown in Table 7, in 2060, more than half

of all countries will have income levels at least as high as that of the US in the 1960s and only around 6% of countries will still be in the extremely low-income group. In 2110, around 78% of countries will be high-income countries and around 15% of countries will still remain in the middle-income group.

The above discussions are the income distribution simulations based on the unconditional transition matrix. Using our regression tree results shown in Figure 4 and Figure 5, we can simulate the counterfactual growth scenarios for countries assuming there are certain changes in fundamentals. One important point we have to keep in mind when using the regression tree to do the growth scenario analysis is that the predicted growth rates for each ending node are the average of the growth rates of countries in the node. We may regard the growth rate as the expected growth rates of those countries featured with those attributes. The difference between the realized growth rate and the average growth rate of the node can be considered as the predictive errors.

One interesting group of countries is the Eastern European countries. As shown in the Appendix, most of them belong to the middle-income group, featured with very favorable demographics (share of population 15–64 years old above 64.4%), relatively higher initial income (above $5,437 per capita), relatively higher government debt share (higher than 41.5%), and with sex ratio of age 0–29 higher than 1.03 in ending node number 21, including Hungary (1990/2000), Bulgaria (1990), Poland (1990/2000), Latvia (2000), Lithuania (2000), and Slovak Republic (2000). They enjoyed a relatively favorable growth condition—their demographics. However, when their demographics turn less favorable, for example, when the population share of 15–64 years old is lower than 64.4%, what they could expect is a growth rate at 2.84% ceteris paribus (featuring ending node number 20), like Hungary (1980) and Romania (1980). If they want to avoid such a scenario, less favorable demographic conditions should be accompanied by improvements in their prudential management of government debt to bring it down to below 41.5% of GDP, which could allow them to relocate to ending node number 18 with an expected growth rate of 4.1%. Romania (1990/2000) and Bulgaria (2000) belong to ending node number 18. However, with even less favorable demographics, for example, when the population share of 15–64 years old is lower than 58.47%, having a relatively good growth performance requires countries to have a relatively low government debt share (lower than 55.91%) and very few crisis years (less than or equal to 1 crisis year in a decade), which can help them grow at a rate of around 3.6% as shown in ending node number 4. Since the above-mentioned country decades have exceeded the income level of $5,437 per capita, it is hard for them to pursue the growth rate of 6.9% as shown in ending node number 11. Hungary (1970), Romania (1970), and Ukraine (2000) are located in ending node number 12. Since Hungary and Romania have passed the income level threshold, they moved to ending node number 21. Ukraine now is allocated to ending node number 12. For the decade 2010–2020, however, since Ukraine's income per capita in 2010 has reached $7,379, it can no longer enjoy the high growth potential associated with countries having a relatively lower initial income, but it expects to have a potential 4% and higher

annual growth for the coming decade since its population share of 15–64 years old is still above 70% in 2010 (with the sex ratio of age 0–29 above 1.031).

Another interesting case is India. In our analysis, the income groups are formed based on the initial income per capita at the beginning of the decade, therefore in all five decades, India was classified in the low-income group. For the most recent decade 2000–2010, India belonged to ending node number 16, featured with a favorable labor force age population share and high sex ratio imbalance. Starting from 2006, India's income per capita of $2,597 exceeded the middle-income threshold. We can use the regression tree for the middle-income group to analyze the growth scenario for India. In 2010, India's population share of 15–64 years old was 64.76%; its initial income in 2010 was $3,437, much below $5,437; and its government debt share was 36.6%. Therefore, it is expected to locate in ending node number 12 with annual growth rate of 4.86%. If India can reduce its government debt share to 31.8% and below, it can have a higher expected growth rate of 6.9% in the coming decade.

Another interesting question which our method can help address is whether the recent astonishing growth rates of the PRC is sustainable. Our model currently does not find any combination of policy choices or fundamentals within the sample that can reliably predict an economic growth miracle (with a growth rate of 7% or higher that is sustained for a decade or more). That is, no ending nodes yield an expected growth rate higher than 7%. So there is no "theory" of growth miracle within the model. That is not a problem for the statistical model per se; it just means that growth miracles are truly exceptional in the data.

Within the model, however, we do observe some of the factors contributing to a growth slowdown in the PRC. Referring to its values in 2010, the PRC still enjoys very favorable demographics (the population share of 15–64 years old is 73.51%, which is much higher than the splitting value of 58.47% at the top layer as shown in Figure 5). However, since the PRC's income per capita has exceeded the threshold value of $5,437 from 2006, it cannot enjoy the high growth rate of 6.9% as indicated by ending node number 11. It ends up in ending node number 18 with expected growth rate of 4.06% (as the sex ratio of age 0–29 is 1.10 and government debt ratio is 22.9%). According to the UN's population forecast, the PRC's sex ratio of age 0–29 will reach 1.15 in 2025 and its population share of 15–64 years old will be higher than 64.4% in the coming two decades. The PRC can expect to have a much lower growth rate of around 4% annually than what it used to have (either ending node number 18 or ending node number 21). Under this scenario, it is going to take around 11 years for the PRC to reach the US's 1960 income level and about 18 years to reach the World Bank defined high-income group with $19,429 income per capita.

5. 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, we reject the 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 a more than 50% chance of having 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 the unconditional transition matrix 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 8.

Conditional on the sample and the regression tree results, we show that for extremely low-income groups, 20 out of 92 country-decades belong to progressive countries, and they have a 75% probability of moving up to the next higher-income group—i.e., the low-income group—within one decade. It only takes 5 years for half of them to move up to the next higher-income group or 17 years for 90% of them to move up. For these countries, there is clearly no low-income trap. For the near-stagnant countries (66 out of 92), the scenario is much worse; the upward decade transition probability is only 12%. It will take 54 years (179 years) for 50% (90%) of them to move up to higher-income groups. For the regressive group (6 out of 92), 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 regressive group of low-income countries (i.e., high inflation and unfavorable demographics), these countries are likely trapped in poverty.

We 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 they are 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 38 years for 90% of the upper-middle-income countries to join the high-income club, but only 25 years for 90% of the lower-middle-income countries to move up, and 22 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 high-income status. The regression tree results therefore provide plausible drivers for growth for countries in a given income group. For a given country, comparing its own policy regimes and fundamentals to these growth drivers 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
ELI	82	18	0	0	0
LI	3	72	25	0	0
LMI	0	3	68	29	0
UMI	0	0	0	70	30
HI	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 (LI)	92	8	0	0
16%–36% (LMI)	13	72	15	0
36%–75% (UMI)	0	4	74	22
75% and above (H)	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 %)

(in 1990 International Geary-Khamis dollars)

	Low	Lower-Middle	Upper-Middle	High
	$1–$1,812	$1,813–$4,078	$4,079–$11,327	$11,328 and above
1850–1900				
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	Bottom 40% Share	Trade	Political Constr.	Conflicts	Pop 1564 Share	Debt	Power Gen.	Paved Road	Railway	Crisis	Oil exporter	Pop 15–64 growth	Global Growth	Credit to Private	Credit to Deposit	Lending-to-deposit Spread	FDI Inflow	Non-FDI Inflow	Sex Ratio Male to Female 0-29
Growth Rate	−0.04	−0.19	0.21	0.13	−0.09	0.19	0.02	0.28	−0.28	0.06	0.13	0.04	−0.23	0.15	0.02	−0.07	0.15	0	0.07	0.21	−0.21	0.25
Initial Income		−0.03	0.34	0.2	0.04	0.14	0.03	0.1	−0.21	0.22	0.41	0.31	−0.03	0.12	0.2	0.16	0.27	0.06	−0.03	0.03	−0.04	0.36
Inflation			0.18	−0.06	−0.26	−0.1	0.04	0.01	0.5	0.04	0.01	0.05	0.56	0.03	−0.09	0.11	−0.14	−0.24	0.07	−0.03	0.32	−0.09
Schooling				−0.06	−0.04	0.21	−0.04	0.24	0.19	0.31	0.17	0.05	0.34	0.14	0.03	−0.36	0.2	−0.21	0.37	0.29	−0.14	0.22
Bottom 40% Share					−0.4	0.06	0.14	0.39	−0.36	−0.03	0.08	−0.06	−0.06	0.17	0.14	−0.08	0.11	0.01	−0.09	−0.18	−0.25	0.5
Trade						−0.1	−0.33	−0.1	−0.2	0.12	0.04	−0.1	−0.36	−0.01	0.08	−0.08	0.04	0.09	0.13	0.41	0.2	−0.13
Political Constr.							0.01	0.15	−0.29	0.14	0.1	−0.03	−0.1	−0.17	0.05	−0.22	0	−0.17	0.15	0.02	−0.16	0.22
Conflicts								0.07	−0.03	0.01	−0.04	0.18	−0.12	−0.01	−0.07	0.32	0.02	−0.04	−0.18	−0.15	0	0.16
Pop 1564 Share									−0.12	0.06	−0.05	0.11	0.11	−0.04	−0.51	0	0.24	0.17	0.05	0.16	−0.21	0.39
Debt										0.33	0.19	−0.16	0.45	0.06	0.07	−0.19	−0.12	−0.19	−0.1	0.32	0.61	−0.15
Power Gen.											0.13	0.19	0.26	0.4	0.07	−0.05	0.03	−0.06	−0.05	0.12	0.01	0.06
Paved Road												0.1	−0.02	0.01	0.02	−0.01	0.13	−0.15	−0.16	0.07	0.03	0.23
Railway													0.02	−0.02	−0.01	0.29	−0.05	0.07	0.06	−0.03	0.21	−0.02
Crisis														−0.14	0.04	−0.07	0.16	0	−0.31	−0.1	0.11	−0.09
Oil exporter															0.16	−0.04	−0.23	−0.23	−0.12	−0.1	−0.25	0.12
Pop 15–64 growth																−0.13	0.04	−0.15	−0.03	−0.21	0.16	0.02
Global Growth																	−0.03	0.2	−0.47	−0.39	0.17	0.1
Credit to Private																		0.53	−0.33	−0.05	0.04	0.23
Credit to Deposit																			−0.15	−0.06	0.1	−0.04
Lending-to-deposit Spread																				0.27	0.05	−0.08
FDI Inflow																					0.03	−0.01
Non-FDI Inflow																						−0.2

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

	Initial Income	Inflation	Schooling	Bottom 40% Share	Trade	Political Constr.	Conflicts	Pop 1564 Share	Debt	Power Gen.	Paved Road	Railway	Crisis	Oil exporter	Pop 15–64 growth	Global Growth	Credit to Private	Credit to Deposit	Lending-to-deposit Spread	FDI Inflow	Non-FDI Inflow	Sex Ratio Male to Female 0-29
Growth Rate	0.05	−0.08	0.25	0.25	−0.07	0.11	0.05	0.41	−0.31	0.06	0.08	0.03	−0.29	0.07	−0.3	−0.01	0.09	0.08	0.2	0.3	−0.12	0.09
Initial Income		−0.05	0.47	0.25	−0.05	0.29	−0.15	0.52	−0.09	0.59	0.44	0.3	−0.05	0.05	−0.44	−0.07	0.21	−0.07	−0.03	0.18	0	0.2
Inflation			0.08	−0.05	−0.21	0.06	0.15	0	0.19	−0.02	−0.12	−0.04	0.64	−0.05	−0.02	0.04	−0.17	0.16	0.15	−0.33	0.04	−0.17
Schooling				0.41	0.16	0.34	−0.19	0.61	0.24	0.49	0.32	0.21	0.02	−0.13	−0.48	−0.42	0.14	−0.1	0.22	0.39	−0.02	0.26
Bottom 40% Share					0.09	−0.08	−0.14	0.47	0.24	0.11	0.28	0.06	0.05	0.01	−0.51	−0.05	−0.07	−0.09	−0.07	0	0	0.45
Trade						−0.1	−0.4	−0.01	0.4	−0.06	−0.12	−0.26	−0.22	0.05	0.18	−0.33	0.25	−0.06	−0.27	0.2	0.11	0.25
Political Constr.							0.06	0.25	−0.1	0.27	0.16	0.02	−0.07	−0.24	−0.25	−0.04	0.11	−0.12	0.28	0.15	−0.17	0.03
Conflicts								−0.09	−0.18	−0.1	−0.09	−0.1	0.06	−0.03	0.1	0.17	−0.16	0.08	0.04	−0.22	−0.08	−0.04
Pop 1564 Share									0.01	0.33	0.17	0.12	−0.08	−0.09	−0.78	−0.26	0.31	−0.01	0.13	0.35	−0.11	0.19
Debt										−0.1	0.05	−0.03	0.11	0.11	−0.02	−0.13	−0.06	−0.17	−0.08	−0.11	0.11	0.04
Power Gen.											0.39	0.34	−0.05	0.01	−0.3	−0.03	0.15	−0.11	0.03	0.08	−0.03	0.27
Paved Road												0.42	−0.21	−0.12	−0.3	0.14	0.04	−0.18	−0.09	0.03	0.05	0.23
Railway													−0.07	−0.22	−0.19	0.28	−0.11	−0.07	0.12	−0.07	0	0.08
Crisis														0.08	0.08	0.01	−0.18	0.01	−0.02	−0.45	0.03	−0.21
Oil exporter															0.24	−0.08	−0.14	−0.02	−0.03	0.04	−0.05	−0.03
Pop 15–64 growth																0.13	−0.02	0.07	−0.24	−0.29	0.06	0.07
Global Growth																	−0.13	0.08	−0.35	−0.55	0.02	0
Credit to Private																		0.28	−0.29	0.16	0.04	0.25
Credit to Deposit																			−0.09	−0.02	0.11	0
Lending-to-deposit Spread																				0.08	0.03	−0.19
FDI Inflow																					0.13	0.03
Non-FDI Inflow																						0.01

Table 6. Conditional Inference Forest Results with 1000 Trees in the Forest with p≤0.05

Rank (1)	Factors (2)	Total (3)	Average (4)	Difference of growth (5)	Frequencies of positive (6)
1	**Population share (15–64)**	**1178**	**53.26**	**1.82**	**86/14**
2	**Paved Road (km/1,000 workers)**	**936**	**1.41**	**0.88**	**64/36**
3	**Sex Ratio Male/Female Age 0–29**	**919**	**1.01**	**2.13**	**89/11**
4	**Population Growth (15–64)**	**877**	**0.24**	**2.46**	**89/11**
5	**Power Generating Capacity (gigawatts/1,000 workers)**	**830**	**0.10**	**1.07**	**70/30**
6	**Log Initial Income**	**758**	**6.92**	**-2.47**	**9/91**
7	**Inflation**	**703**	**11.95**	**-1.78**	**12/88**
8	**Years of Schooling**	**683**	**2.91**	**2.09**	**89/11**
9	**No. of Crises**	**612**	**1.83**	**-2.42**	**7/93**
10	**FDI Inflow 4 Years**	**583**	**5.65**	**2.63**	**94/6**
11	**Global Growth Rate**	**578**	**0.02**	**0.86**	**67/33**
12	Domestic Credit to Private Sector % of GDP	484	15.25	1.68	86/14
13	Log Conflicts Index	476	4.51	-0.76	37/63
14	Bank Credit to Deposit Ratio	467	99.33	-0.80	32/68
15	Political Constraints	417	0.15	2.27	89/11
16	Government Debt Share	338	48.91	-1.43	8/92
17	Non-FDI Inflow 4 Years	317	15.03	-1.91	6/94
18	Trade Share	298	61.03	-1.31	11/89
19	Railway (km/1,000 workers)	266	0.38	1.10	76/24
20	Bank Lending-to-deposit Spread	180	8.35	1.78	78/22
21	Oil exporter or Not	125	0.00	3.18	79/21
22	Income Share of Bottom 40%	98	26.83	0.06	47/53

Middle-Income					
Rank (1)	Factors (2)	Total (3)	Average split (4)	Difference of growth (5)	Frequencies of (6)
1	**Population Share (15–64)**	**2077**	**59.52**	**2.09**	**96/4**
2	**Government Debt Share**	**1578**	**42.99**	**-2.10**	**3/97**
3	**No. of Crises**	**1516**	**2.49**	**-1.81**	**3/97**
4	**Log Initial Income**	**1478**	**8.58**	**-2.25**	**8/92**
5	**Inflation**	**1004**	**13.44**	**-1.09**	**33/67**
6	**Years of Schooling**	**719**	**6.30**	**0.87**	**58/42**
7	**Sex Ratio Male/Female Age 0–29**	**707**	**1.03**	**0.99**	**76/24**
8	**Political Constraints**	**686**	**0.30**	**0.74**	**73/27**
9	**Log Conflicts Index**	**620**	**4.07**	**0.98**	**65/35**
10	**Credit to Deposit Ratio**	**602**	**99.59**	**0.89**	**61/39**
11	Global Growth Rate	492	0.02	1.71	90/10
12	FDI Inflow 4 Years	449	10.04	1.54	93/7
13	Trade Share	391	60.09	-1.16	26/74
14	Bank Lending-to-Deposit Spread	360	7.12	1.24	89/11
15	Paved Road (km/1,000 workers)	352	3.59	1.25	76/24
16	Population Growth (15–64)	317	0.15	-0.33	37/63
17	Oil Exporter or Not	309	0.00	1.46	85/15
18	Domestic Credit to Private Sector % of GDP	291	27.02	0.55	56/44
19	Power Generating Capacity (gigawatts/1,000 workers)	239	0.65	-0.18	44/56
20	Non-FDI Inflow 4 Years	182	13.03	-0.61	38/62
21	Income Share of Bottom 40%	179	25.88	1.05	68/32
22	Railway (km/1,000 workers)	170	0.74	-0.22	42/58

Table 7. World Income Distribution Simulations for 2060 and 2110 (unit: %)

	2010	2060	2110
ELI	13.08	5.61	2.80
LI	17.76	9.35	4.67
LMI	16.82	11.21	5.61
UMI	22.43	14.95	9.35
HI	29.91	58.88	77.57

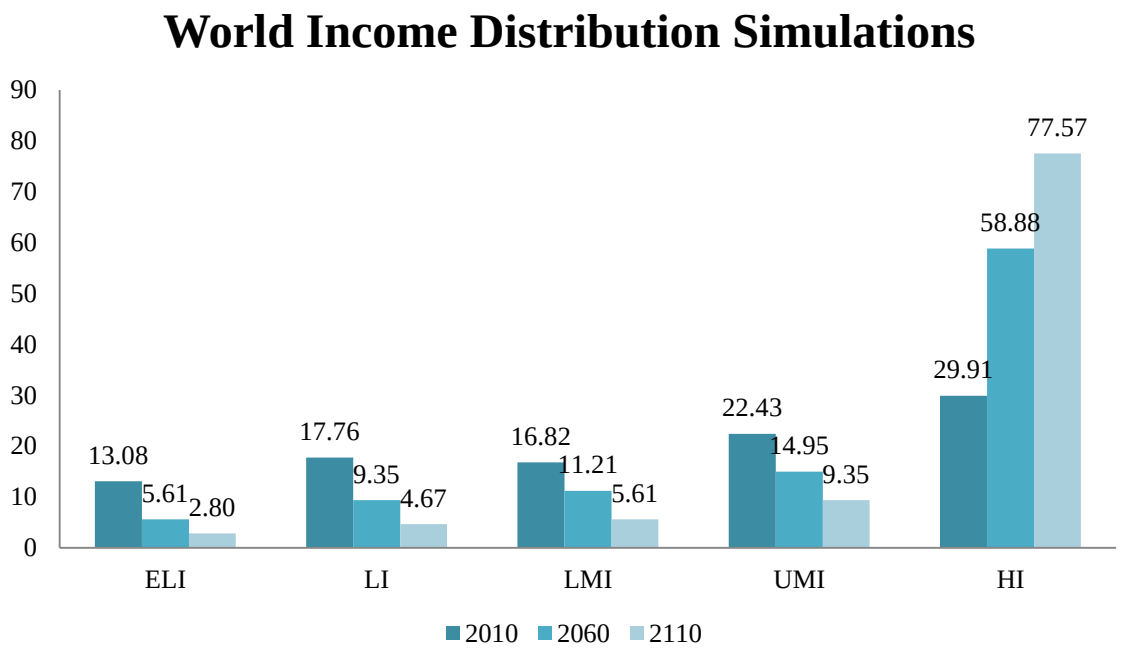
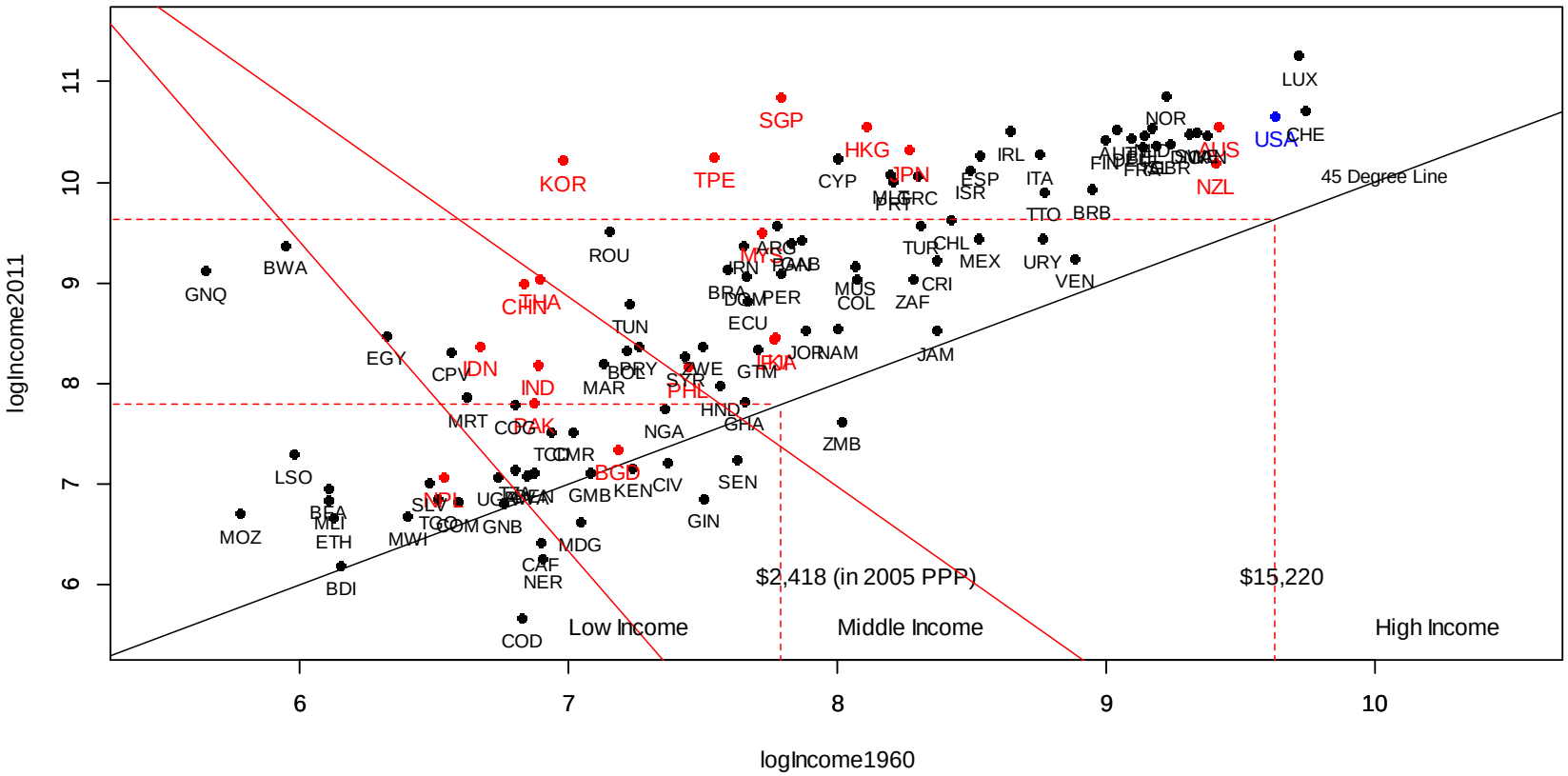


Table 8. Regression-Tree-Simulated Transition Matrix (in %)

	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	20/92	0.22	25	75	0	0	0	5	17
Near-stagnant	66/92	0.72	88	12	0	0	0	54	179
Regressive	6/92	0.07	100	0	0	0	0	never	never
Low-Income Countries									
Progressive	43/112	0.38	0	35	65	0	0	7	22
Near-stagnant	53/112	0.47	0	89	11	0	0	58	192
Regressive	16/112	0.14	38	62	0	0	0	never	never
Lower-Middle-Income Countries									
Progressive	46/92	0.5	0	0	39	61	0	8	25
Near-stagnant	37/92	0.4	0	0	89	11	0	61	202
Regressive	9/92	0.1	0	22	78	0	0	never	never
Upper-Middle-Income Countries									
Progressive	50/114	0.44	0	0	0	54	46	12	38
Near-stagnant	62/114	0.54	0	0	0	81	19	33	108
Regressive	2/114	0.02	0	0	0	100	0	never	never

Figure 1. Income Transition from 1960 to 2011[20]



[20] Some Central Asian countries are missing because of data unavailability.

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

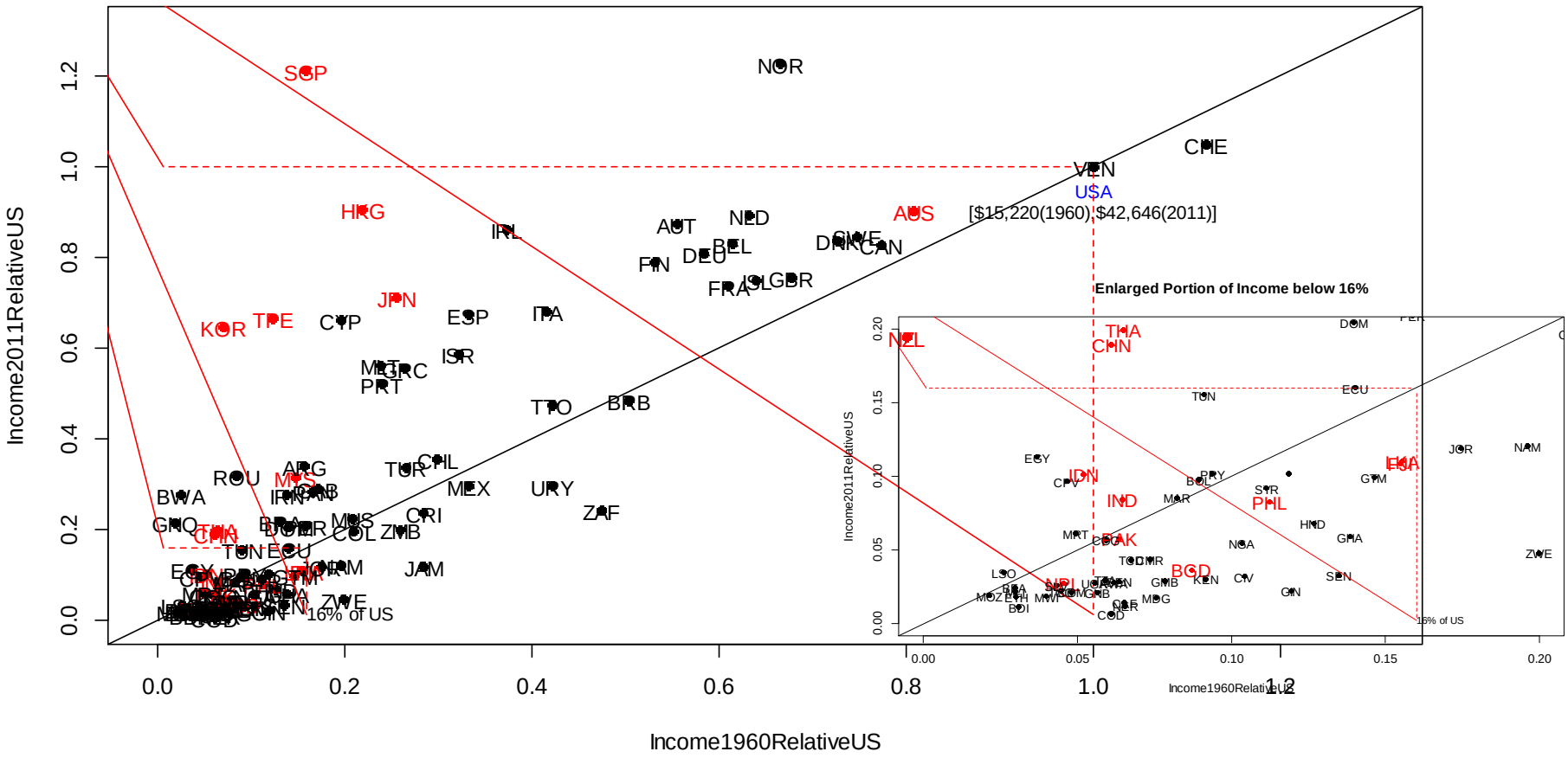
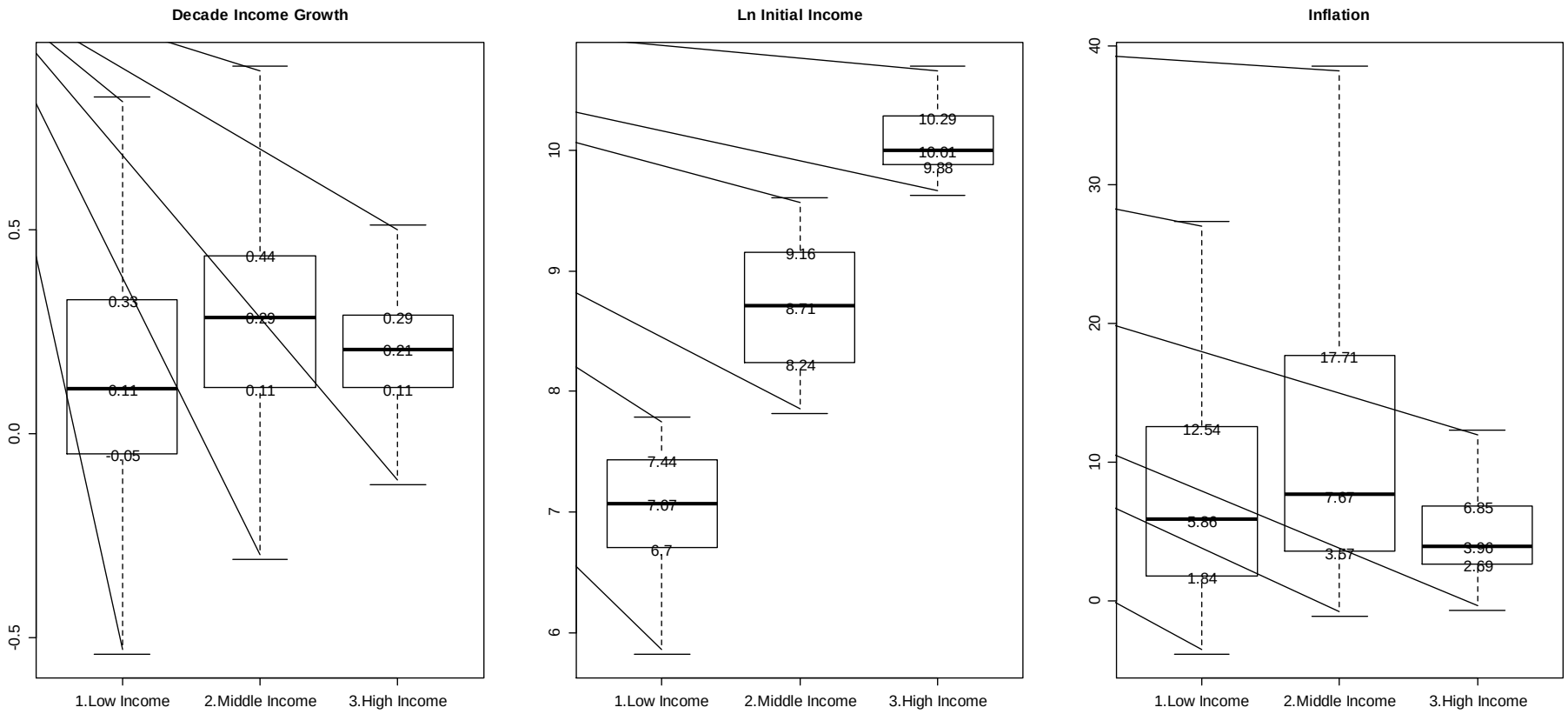
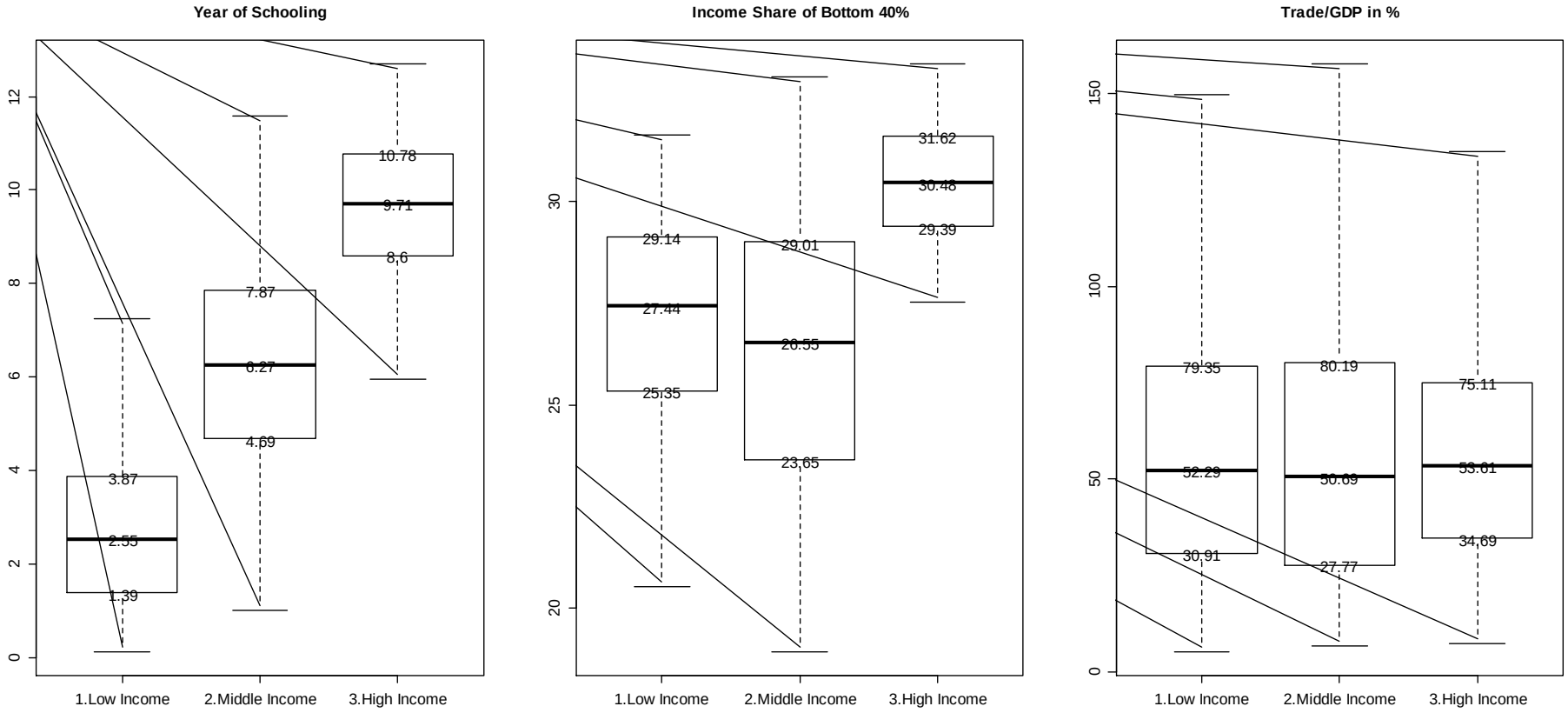
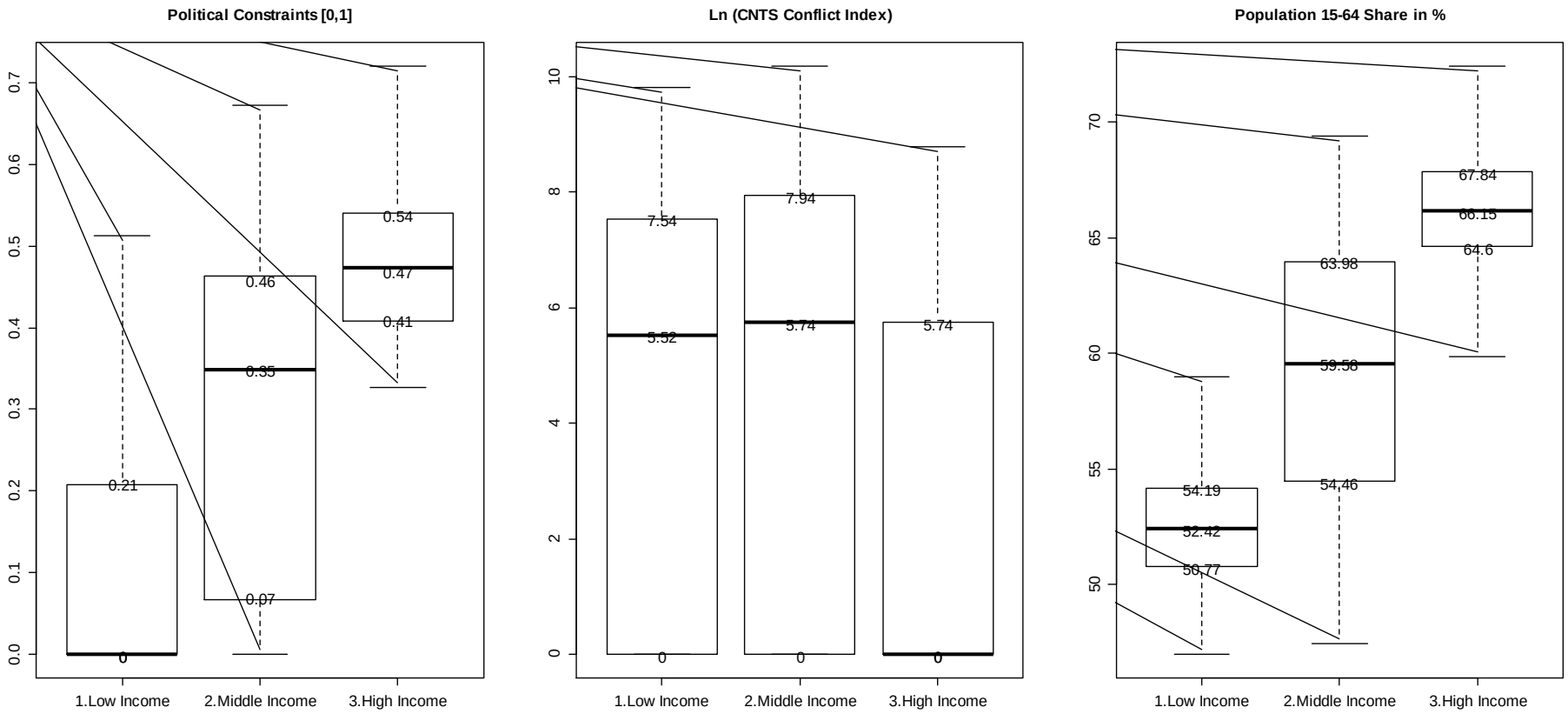
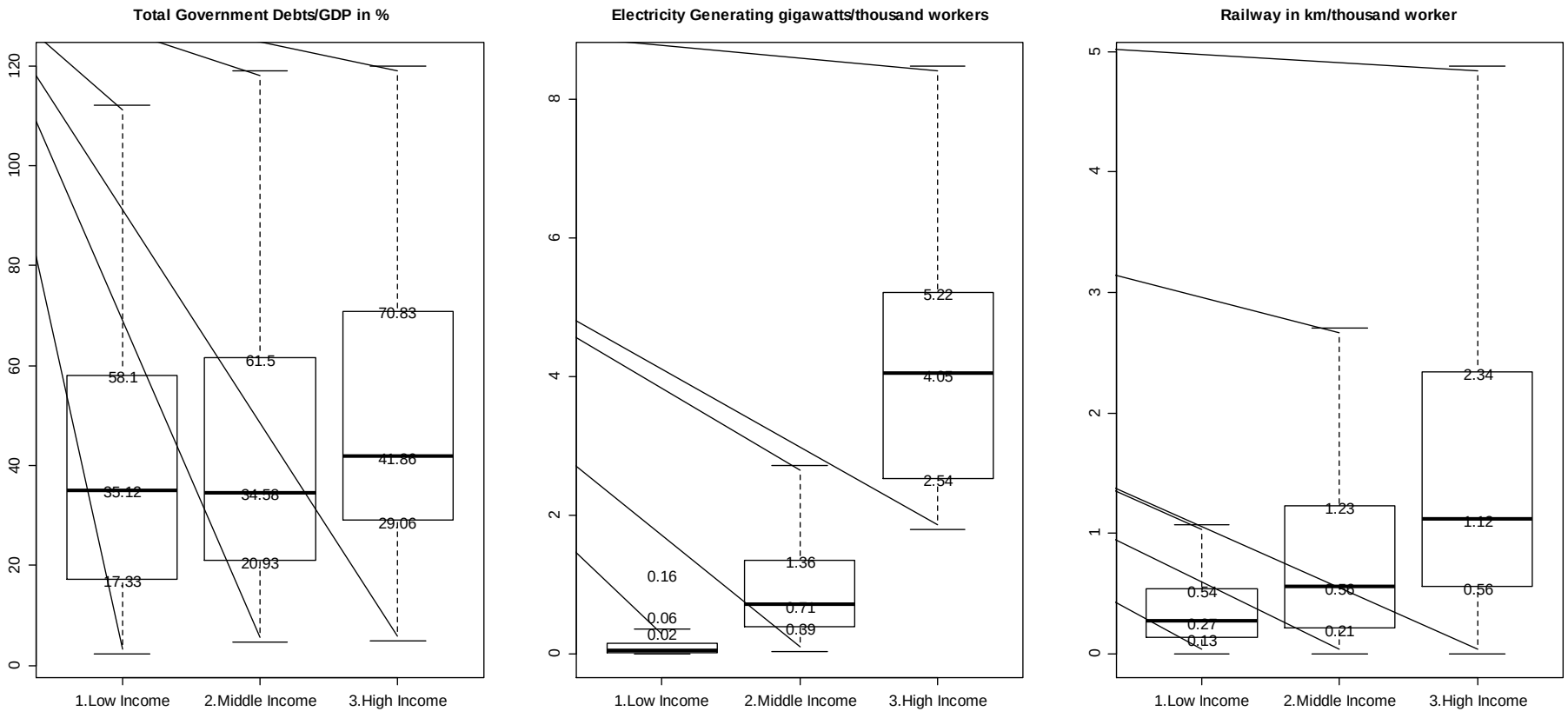


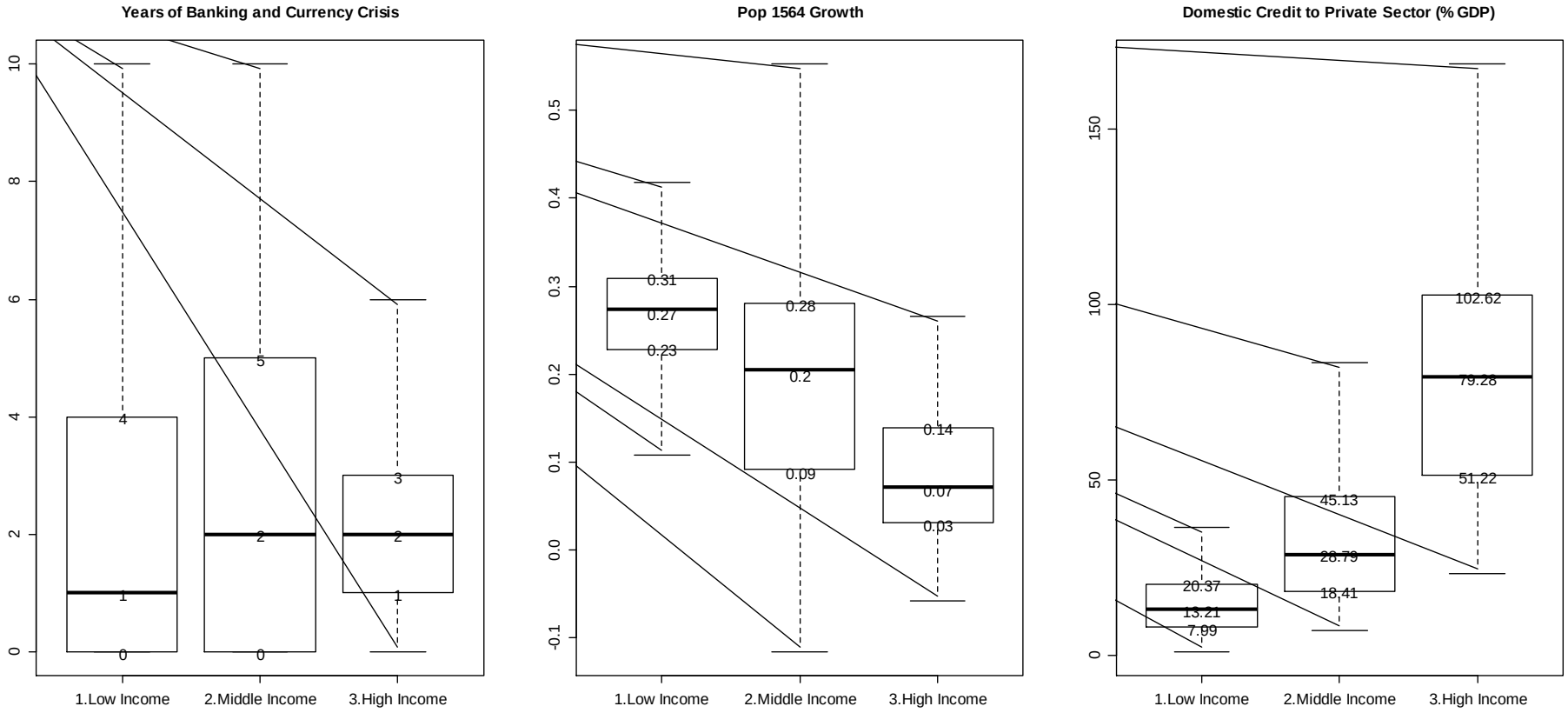
Figure 3. Box Whisker Plots for Variables

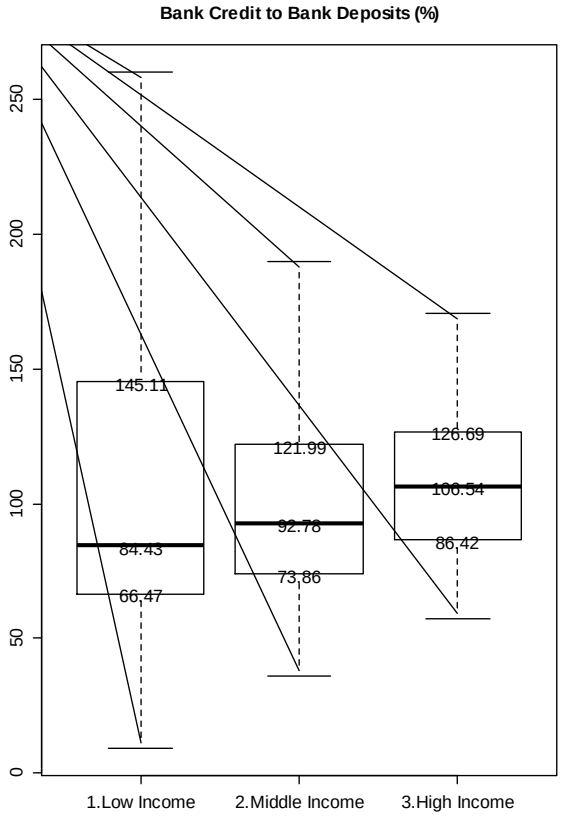


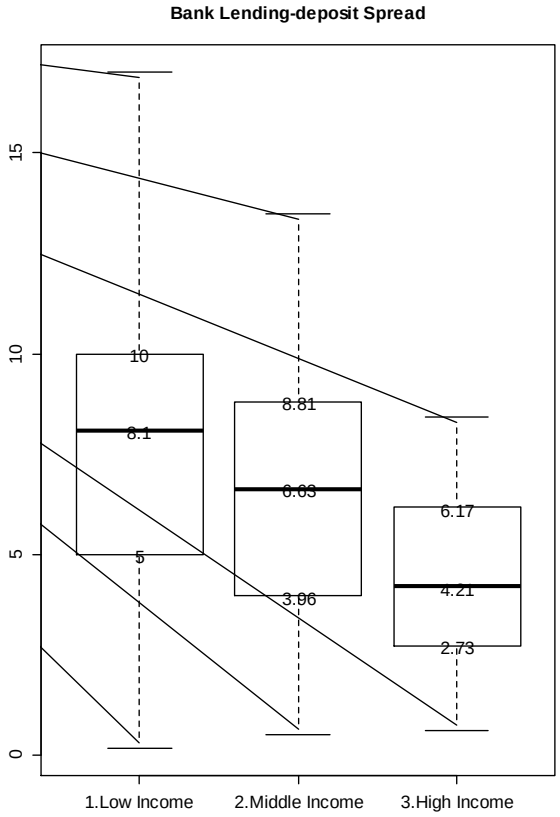

Year of Schooling
0
2
4
6
8
10
12
3.87
2.55
1.39
7.87
6.27
4.69
10.78
9.71
8.6
1.Low Income
2.Middle Income
3.High Income
Income Share of Bottom 40%
20
25
30
29.14
27.44
25.35
29.01
26.55
23.65
31.62
30.48
29.39
1.Low Income
2.Middle Income
3.High Income
Trade/GDP in %
0
50
100
150
79.35
52.29
30.91
80.19
50.69
27.77
75.11
53.61
34.69
1.Low Income
2.Middle Income
3.High Income

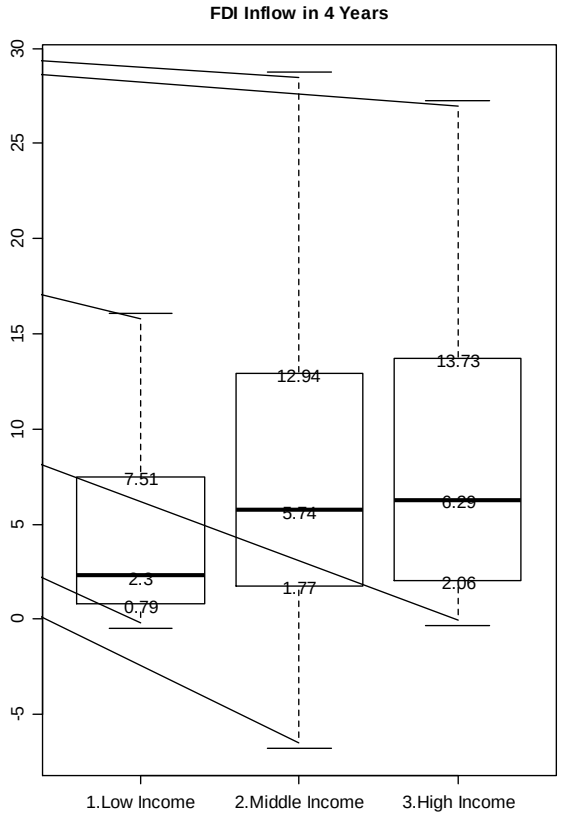

Political Constraints [0,1]
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.21
0
0.46
0.35
0.07
0.54
0.47
0.41
1.Low Income
2.Middle Income
3.High Income
Ln (CNTS Conflict Index)
0
2
4
6
8
10
7.54
5.52
0
7.94
5.74
0
5.74
0
1.Low Income
2.Middle Income
3.High Income
Population 15-64 Share in %
50
55
60
65
70
54.19
52.42
50.77
63.98
59.58
54.46
67.84
66.15
64.6
1.Low Income
2.Middle Income
3.High Income

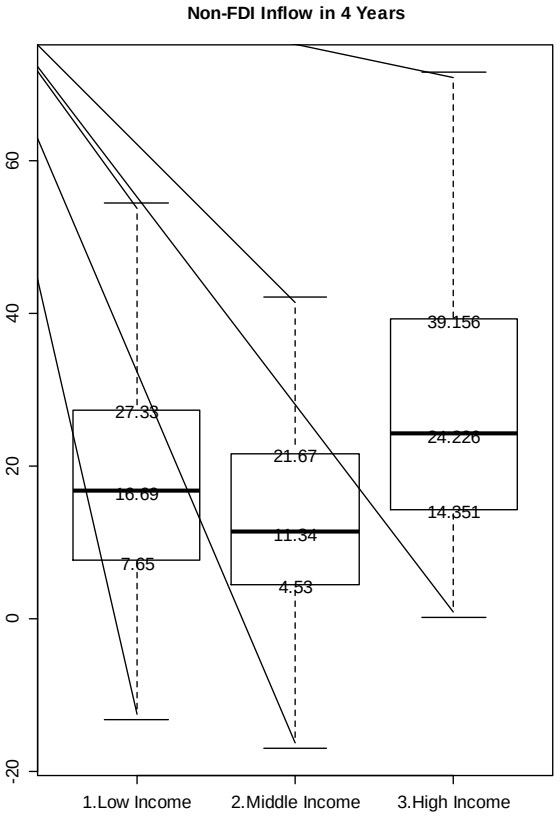

Total Government Debts/GDP in %
0
20
40
60
80
100
120
58.1
35.12
17.33
61.5
34.58
20.93
70.83
41.86
29.06
1.Low Income
2.Middle Income
3.High Income
Electricity Generating gigawatts/thousand workers
0
2
4
6
8
0.16
0.06
0.02
1.36
0.71
0.89
5.22
4.05
2.54
1.Low Income
2.Middle Income
3.High Income
Railway in km/thousand worker
0
1
2
3
4
5
0.54
0.27
0.13
1.23
0.56
0.21
2.34
1.12
0.56
1.Low Income
2.Middle Income
3.High Income


Years of Banking and Currency Crisis
10
8
6
4
2
0
4
1
0
5
2
0
3
2
1
1.Low Income
2.Middle Income
3.High Income
Pop 1564 Growth
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
0.31
0.27
0.23
0.28
0.2
0.09
0.14
0.07
0.03
1.Low Income
2.Middle Income
3.High Income
Domestic Credit to Private Sector (% GDP)
150
100
50
0
102.62
79.28
51.22
45.13
28.79
18.41
20.37
13.21
7.99
1.Low Income
2.Middle Income
3.High Income


Bank Credit to Bank Deposits (%)
0
50
100
150
200
250
145.11
84.43
66.47
121.99
92.78
73.86
126.69
106.54
86.42
1.Low Income
2.Middle Income
3.High Income


Bank Lending-deposit Spread
0
5
10
15
10
8.1
5
8.81
6.63
3.96
6.17
4.21
2.73
1.Low Income
2.Middle Income
3.High Income


FDI Inflow in 4 Years
-5
0
5
10
15
20
25
30
7.51
2.3
0.79
12.94
5.74
1.77
13.73
6.29
2.06
1.Low Income
2.Middle Income
3.High Income


Non-FDI Inflow in 4 Years
60
40
20
0
-20
27.33
16.69
7.65
21.67
11.34
4.53
39.156
24.226
14.351
1.Low Income
2.Middle Income
3.High Income

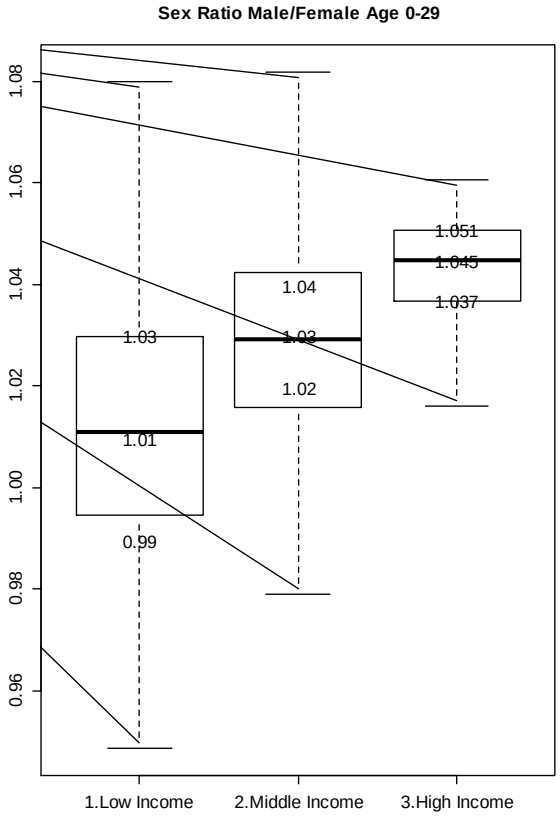
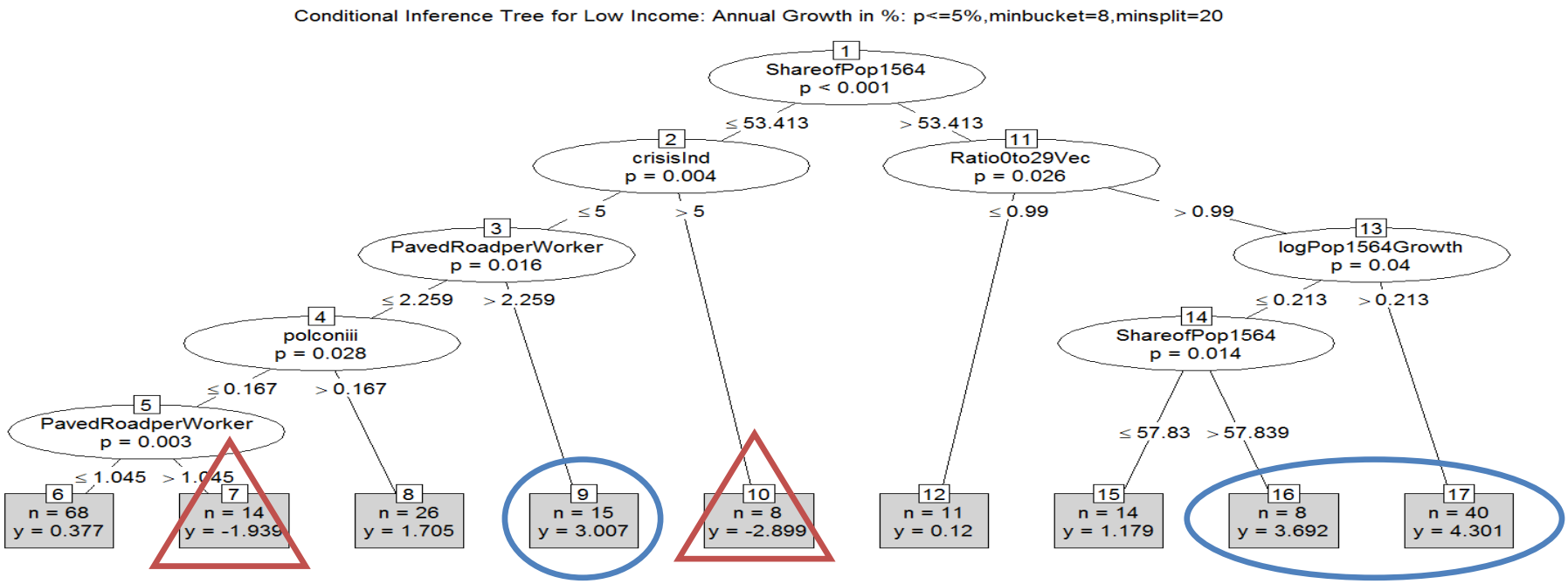
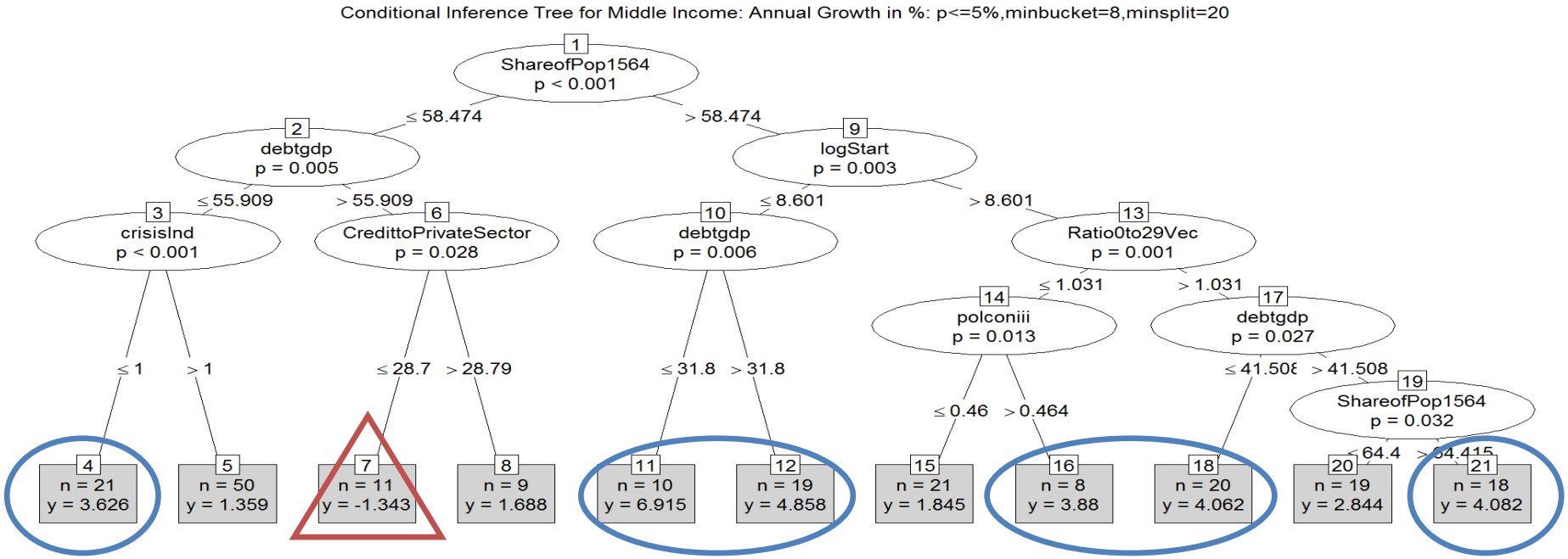

Sex Ratio Male/Female Age 0-29
1.08
1.06
1.04
1.02
1.00
0.98
0.96
1.03
1.01
0.99
1.04
1.03
1.02
1.051
1.045
1.037
1.Low Income
2.Middle Income
3.High Income

Figure 4. Conditional Inference Tree for Low-Income Countries



6	7	8	9	10	12	15	16	17
Pakistan /1980 (2.04)	Guinea /1990 (-4.25)	Philippines /1990 (1.97)	Malaysia /1960 (2.0)	Zambia /1990 (-3.01)	Indonesia /1960 (0.44)	Nepal /2000 (1.19)	Sri Lanka /1980 (4.7)	China /1990 (5.64)
Rwanda /1960 (0.33)	Niger /1990 (-1.68)	Pakistan /1970 (1.05)	Morocco /1980 (3.8)	Kenya /1990 (-1.9)	Central African Republic/1980 (0.50)	India /1960 (2.22)	Bangladesh /2000 (2.47)	India /2000 (6.48)

Figure 5. Conditional Inference Tree for Middle-Income Countries



4	5	7	8	11	12	15	16	18	20	21
Turkey /1960 (3.52)	Philippines /1980 (1.15)	Sri Lanka /1970 (-4.46)	Malaysia /1980 (0.93)	PRC /2000 (8.07)	Sri Lanka /2000 (3.27)	Uruguay /1990 (1.79)	Thailand /2000 (3.39)	Norway /1970 (3.85)	Netherlands /1970 (2.84)	Poland /2000 (4.11)
Malaysia /1970 (7.6)	Turkey /1970 (1.48)	Mexico /1980 (-1,55)	Bolivia /2000 (3.50)	Korea, Rep. / 1980 (9.42)	Indonesia /2000 (2.48)	Portugal /1970 (2.76)	Japan /1970 (4.08)	Malaysia /1990 (4.67)	Malaysia /2000 (2.80)	Lithuania /2000 (4.76)

Appendix

Linkage between our income group classifications and the World Bank classifications

The World Bank classifies countries according to the following thresholds in 2013 US dollars (Atlas method):

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 8.0. 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.

Group Averages in Different Units

	Atlas method (2013 US dollars)	PPP (2005 international dollars)
L	664	1,536
LM	2,068	5,152
UM	7,540	11,494
H	39,312	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

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 the extremely low-income group decreased sharply in the decade 2000–2010 while there was no clear rising or declining trend in the probabilities for the low-income to stay in the low-income group, but also with a peak value for the decade 1990–2000; (2) for decades 1970–1980, 1980–1990, and 1990–2000, the probabilities for extremely low-income countries to stay extremely low-income are higher than those for low-income countries to stay low-income; (3) the probabilities for those in the low-income level to fall back to the extremely low-income group 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 the low-income to move up to lower-middle-income, with the decade 2000–2010 as second best. The decade 1980–1990 stands out as one with the least probability for countries in the lower-middle-income group to move up to upper-middle-income status, followed by the decade 2000–2010, for which the upper-middle-income had the highest probability of remaining in the same group. For lower-middle-income countries, the decade 1980–1990 is the hardest decade to move up while for upper-middle-income countries, the decade 2000–2010 is the most difficult.

Given the very low probability for upper-middle-income countries to move up to the high-income group in the 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 the 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 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. It shows that the probability of transition from extremely low to low-income and low-income to middle-income 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 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 2000–2007 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.

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

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

Economy	1960	1980	2011
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

Economy	1960	1980	2011
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

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 and banking 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 FDI and non-FDI inflows in GDP;	✓	✓	
6. Good governance: political constraints indices by Henisz (2002);	✓	✓	
7. Inequality: share of population with incomes belonging to the bottom 40%	✓		
8. Initial Income level;			✓
9. Demography: share of population aged 15–64, changes of log (population aged 15–64), and sex ratio of age 0–29;			✓
10. Global economic environment: growth rate of the leading economies;			✓
11. Financial development: domestic credit to private sector, bank credit to deposit, bank lending-to-deposit rate spread; and			✓
12. Oil exporter indicator.			✓

Note: In the eight key actions of ADB, one action is not covered in our analysis - a clear vision for the future since it is hard to find an appropriate indicator.

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

Economy	Decade Start	Actual Annual Growth	Initial Income	Predicted Growth	End Node Number	Absolute Value of Predicted Error
(1)	(2)	(3)	(4)	(5)	(6)	abs[(3)–(5)]
Ecuador	1960	1.73	$2,134	0.38	6	1.35
El Salvador	1960	2.23	$655	0.38	6	1.85
Iran, Islamic Rep.	1960	3.73	$2,100	0.38	6	3.35
Kenya	1960	0.55	$1,396	0.38	6	0.17
Niger	1960	0.35	$995	0.38	6	0.03
Paraguay	1960	2.44	$1,426	0.38	6	2.06
Rwanda	1960	0.33	$940	0.38	6	0.05
Syrian Arab Republic	1960	4.95	$1,692	0.38	6	4.57
Benin	1970	0.18	$1,154	0.38	6	0.20
Burundi	1970	0.76	$558	0.38	6	0.38
Congo, Rep.	1970	4.91	$1,271	0.38	6	4.53
Cote d'Ivoire	1970	–1.19	$2,363	0.38	6	1.57
Ethiopia	1970	1.1	$557	0.38	6	0.72
Kenya	1970	1.23	$1,475	0.38	6	0.85
Lesotho	1970	3.94	$537	0.38	6	3.56
Madagascar	1970	–2.89	$1,327	0.38	6	3.27
Malawi	1970	–0.1	$775	0.38	6	0.48
Mauritania	1970	–0.44	$1,665	0.38	6	0.82
Niger	1970	–0.08	$1,030	0.38	6	0.46
Paraguay	1970	5.23	$1,815	0.38	6	4.85
Rwanda	1970	1.29	$971	0.38	6	0.91
Sudan	1970	0.71	$1,010	0.38	6	0.33
Tanzania	1970	0.26	$1,287	0.38	6	0.12
Togo	1970	1.17	$1,082	0.38	6	0.79
Uganda	1970	–5.27	$985	0.38	6	5.65
Benin	1980	–1.16	$1,175	0.38	6	1.54
Burkina Faso	1980	–0.05	$628	0.38	6	0.43
Burundi	1980	–0.53	$602	0.38	6	0.91
Cameroon	1980	1.56	$1,815	0.38	6	1.18
Congo, Rep.	1980	–1.93	$2,052	0.38	6	2.31
Cote d'Ivoire	1980	–0.48	$2,096	0.38	6	0.86
Ethiopia	1980	0.18	$621	0.38	6	0.20
Lesotho	1980	0.88	$790	0.38	6	0.50
Liberia	1980	–8.95	$1,378	0.38	6	9.33
Malawi	1980	–1.27	$767	0.38	6	1.65
Mali	1980	3.15	$466	0.38	6	2.77
Mauritania	1980	–1.71	$1,593	0.38	6	2.09
Mozambique	1980	–3.28	$469	0.38	6	3.66

Economy	Decade Start	Actual Annual Growth	Initial Income	Predicted Growth	End Node Number	Absolute Value of Predicted Error
(1)	(2)	(3)	(4)	(5)	(6)	abs[(3)–(5)]
Niger	1980	–5.04	$1,022	0.38	6	5.42
Pakistan	1980	2.04	$1,613	0.38	6	1.66
Rwanda	1980	–0.32	$1,104	0.38	6	0.70
Sudan	1980	0.55	$1,085	0.38	6	0.17
Tanzania	1980	–4.47	$1,322	0.38	6	4.85
Uganda	1980	0.88	$573	0.38	6	0.50
Benin	1990	1.17	$1,045	0.38	6	0.79
Burkina Faso	1990	1.44	$625	0.38	6	1.06
Burundi	1990	–2.4	$571	0.38	6	2.78
Cameroon	1990	–1.25	$2,120	0.38	6	1.63
Cote d'Ivoire	1990	–1.81	$1,997	0.38	6	2.19
Ethiopia	1990	–3.67	$632	0.38	6	4.05
Lesotho	1990	1.69	$862	0.38	6	1.31
Liberia	1990	–0.45	$539	0.38	6	0.83
Madagascar	1990	–1.06	$925	0.38	6	1.44
Malawi	1990	–1.37	$675	0.38	6	1.75
Mali	1990	2.07	$635	0.38	6	1.69
Mauritania	1990	0.29	$1,340	0.38	6	0.09
Mozambique	1990	2.32	$336	0.38	6	1.94
Rwanda	1990	–4.47	$1,069	0.38	6	4.85
Sudan	1990	2.01	$1,147	0.38	6	1.63
Tanzania	1990	–1.09	$836	0.38	6	1.47
Uganda	1990	3.13	$625	0.38	6	2.75
Burkina Faso	2000	3.55	$721	0.38	6	3.17
Burundi	2000	0.52	$448	0.38	6	0.14
Cameroon	2000	–0.21	$1,870	0.38	6	0.59
Ethiopia	2000	5.68	$435	0.38	6	5.30
Mali	2000	1.9	$780	0.38	6	1.52
Rwanda	2000	5.3	$677	0.38	6	4.92
Sudan	2000	5.17	$1,399	0.38	6	4.79
Ghana	1960	0.03	$2,108	–1.94	7	1.97
Senegal	1970	–0.92	$1,634	–1.94	7	1.02
El Salvador	1980	–2.45	$905	–1.94	7	0.51
Gambia, The	1980	0.05	$1,128	–1.94	7	1.99
Syrian Arab Republic	1980	–7.9	$2,394	–1.94	7	5.96
Togo	1980	–2.33	$1,215	–1.94	7	0.39
Gambia, The	1990	0.3	$1,135	–1.94	7	2.24
Guinea	1990	–4.25	$1,920	–1.94	7	2.31
Niger	1990	–1.68	$609	–1.94	7	0.26
Senegal	1990	–2	$1,889	–1.94	7	0.06

Economy	Decade Start	Actual Annual Growth	Initial Income	Predicted Growth	End Node Number	Absolute Value of Predicted Error
(1)	(2)	(3)	(4)	(5)	(6)	abs[(3)–(5)]
Sierra Leone	1990	–6.52	$1,408	–1.94	7	4.58
Togo	1990	–1.63	$960	–1.94	7	0.31
Gambia, The	2000	1.21	$1,169	–1.94	7	3.15
Togo	2000	0.95	$815	–1.94	7	2.89
Guatemala	1960	2.66	$2,223	1.71	8	0.96
Honduras	1960	0.92	$1,924	1.71	8	0.79
Peru	1960	3.34	$2,416	1.71	8	1.64
Philippines	1960	1.97	$1,708	1.71	8	0.27
El Salvador	1970	1.03	$817	1.71	8	0.68
Ghana	1970	–2.53	$2,115	1.71	8	4.24
Honduras	1970	2.39	$2,109	1.71	8	0.69
Pakistan	1970	1.05	$1,453	1.71	8	0.66
Philippines	1970	2.87	$2,076	1.71	8	1.17
Thailand	1970	3.66	$1,982	1.71	8	1.96
Madagascar	1980	–0.67	$989	1.71	8	2.38
Senegal	1980	2.41	$1,489	1.71	8	0.71
Sierra Leone	1980	2.41	$1,109	1.71	8	0.71
Congo, Rep.	1990	0.75	$1,689	1.71	8	0.96
Pakistan	1990	0.39	$1,974	1.71	8	1.32
Benin	2000	0.41	$1,174	1.71	8	1.30
Guinea	2000	–2.73	$1,244	1.71	8	4.44
Kenya	2000	–0.48	$1,337	1.71	8	2.19
Madagascar	2000	–0.8	$832	1.71	8	2.51
Malawi	2000	3.06	$588	1.71	8	1.36
Mozambique	2000	6.3	$423	1.71	8	4.60
Niger	2000	0.25	$514	1.71	8	1.46
Senegal	2000	–0.49	$1,543	1.71	8	2.20
Tanzania	2000	4.81	$750	1.71	8	3.11
Uganda	2000	3.27	$851	1.71	8	1.57
Zambia	2000	8.08	$946	1.71	8	6.38
Dominican Republic	1960	2.45	$2,125	3.01	9	0.56
Malaysia	1960	2	$2,252	3.01	9	1.01
Morocco	1960	4.36	$1,249	3.01	9	1.35
Sri Lanka	1960	0.8	$2,365	3.01	9	2.21
Zimbabwe	1960	1.66	$1,805	3.01	9	1.35
Cape Verde	1970	–0.23	$966	3.01	9	3.24
Morocco	1970	2.13	$1,915	3.01	9	0.88
Tunisia	1970	5.39	$2,200	3.01	9	2.38
Zimbabwe	1970	0.79	$2,128	3.01	9	2.22
Cape Verde	1980	3.96	$943	3.01	9	0.95

Economy	Decade Start	Actual Annual Growth	Initial Income	Predicted Growth	End Node Number	Absolute Value of Predicted Error
(1)	(2)	(3)	(4)	(5)	(6)	abs[(3)–(5)]
Morocco	1980	3.8	$2,364	3.01	9	0.79
Zimbabwe	1980	5.05	$2,303	3.01	9	2.04
Cape Verde	1990	5.3	$1,391	3.01	9	2.29
Syrian Arab Republic	1990	1.91	$1,051	3.01	9	1.10
Cape Verde	2000	5.74	$2,332	3.01	9	2.73
Ghana	1980	–1.66	$1,637	–2.90	10	1.24
Kenya	1980	–0.28	$1,667	–2.90	10	2.62
Nigeria	1980	–14.08	$1,857	–2.90	10	11.18
Zambia	1980	–1.26	$1,459	–2.90	10	1.64
Central African Republic	1990	–1.23	$756	–2.90	10	1.67
Kenya	1990	–1.9	$1,621	–2.90	10	1.00
Nigeria	1990	0.23	$407	–2.90	10	3.13
Zambia	1990	–3.01	$1,285	–2.90	10	0.11
Indonesia	1960	0.44	$790	0.12	12	0.32
Central African Republic	1970	–3.56	$1,033	0.12	12	3.68
Liberia	1970	–1.46	$1,596	0.12	12	1.58
Mozambique	1970	1.4	$408	0.12	12	1.28
Sierra Leone	1970	–0.64	$1,183	0.12	12	0.76
Central African Republic	1980	0.5	$719	0.12	12	0.38
Guinea	1980	–0.58	$2,035	0.12	12	0.70
El Salvador	1990	3.48	$707	0.12	12	3.36
Central African Republic	2000	–0.98	$668	0.12	12	1.10
El Salvador	2000	1.09	$994	0.12	12	0.97
Sierra Leone	2000	1.63	$717	0.12	12	1.51
Cameroon	1960	1	$1,117	1.18	15	0.18
China, People’s Rep. of	1960	0.41	$928	1.18	15	0.77
India	1960	2.22	$982	1.18	15	1.04
Mali	1960	0.06	$450	1.18	15	1.12
Nigeria	1960	0.88	$1,573	1.18	15	0.30
Tunisia	1960	4.77	$1,381	1.18	15	3.59
Burkina Faso	1970	2.23	$504	1.18	15	1.05
Gambia, The	1970	–1.15	$1,267	1.18	15	2.33
Mali	1970	0.29	$452	1.18	15	0.89
Nepal	1970	–0.85	$754	1.18	15	2.03
Nepal	1980	2.88	$692	1.18	15	1.70
Cote d'Ivoire	2000	–0.74	$1,663	1.18	15	1.92
Lesotho	2000	3.32	$1,020	1.18	15	2.14
Nepal	2000	1.19	$1,036	1.18	15	0.01
Argentina	1960	2.16	$2,383	3.69	16	1.53
Nepal	1960	0.89	$690	3.69	16	2.80

Economy	Decade Start	Actual Annual Growth	Initial Income	Predicted Growth	End Node Number	Absolute Value of Predicted Error
(1)	(2)	(3)	(4)	(5)	(6)	abs[(3)–(5)]
Romania	1960	7.07	$1,276	3.69	16	3.38
Sri Lanka	1980	4.7	$1,623	3.69	16	1.01
China, People's Rep. of	1990	5.64	$2,041	3.69	16	1.95
Bangladesh	2000	2.47	$1,167	3.69	16	1.22
India	2000	6.48	$1,831	3.69	16	2.79
Kyrgyz Republic	2000	0.13	$2,077	3.69	16	3.56
Bolivia	1960	1.82	$1,360	4.30	17	2.48
Brazil	1960	4.63	$1,982	4.30	17	0.33
Congo, Rep.	1960	3.5	$901	4.30	17	0.80
Cote d'Ivoire	1960	4.08	$1,584	4.30	17	0.22
Egypt, Arab Rep.	1960	4.93	$560	4.30	17	0.63
Korea, Rep. of	1960	5.89	$1,074	4.30	17	1.59
Mauritania	1960	8.29	$751	4.30	17	3.99
Pakistan	1960	4.18	$965	4.30	17	0.12
Senegal	1960	–2.25	$2,052	4.30	17	6.55
Singapore	1960	8.11	$2,413	4.30	17	3.81
Thailand	1960	7.23	$986	4.30	17	2.93
Togo	1960	4.82	$676	4.30	17	0.52
Bolivia	1970	1.93	$1,629	4.30	17	2.37
Cameroon	1970	3.94	$1,234	4.30	17	0.36
China, People's Rep. of	1970	3.19	$967	4.30	17	1.11
Egypt, Arab Rep.	1970	1.66	$905	4.30	17	2.64
India	1970	–1.28	$1,222	4.30	17	5.58
Indonesia	1970	8.62	$825	4.30	17	4.32
Korea, Rep. of	1970	8.59	$1,904	4.30	17	4.29
Nigeria	1970	0.79	$1,716	4.30	17	3.51
Bolivia	1980	0.29	$1,972	4.30	17	4.01
China, People's Rep. of	1980	4.42	$1,324	4.30	17	0.12
Egypt, Arab Rep.	1980	5.51	$1,068	4.30	17	1.21
India	1980	1.25	$1,075	4.30	17	3.05
Indonesia	1980	3.8	$1,887	4.30	17	0.50
Bangladesh	1990	–0.56	$1,234	4.30	17	4.86
Bolivia	1990	3.32	$2,030	4.30	17	0.98
Egypt, Arab Rep.	1990	7.97	$1,826	4.30	17	3.67
Ghana	1990	1.83	$1,385	4.30	17	2.47
India	1990	4.17	$1,217	4.30	17	0.13
Nepal	1990	1.21	$919	4.30	17	3.09
Cambodia	2000	7.88	$1,023	4.30	17	3.58
Congo, Rep.	2000	2.71	$1,820	4.30	17	1.59
Ghana	2000	3.55	$1,661	4.30	17	0.75

Economy	Decade Start	Actual Annual Growth	Initial Income	Predicted Growth	End Node Number	Absolute Value of Predicted Error
(1)	(2)	(3)	(4)	(5)	(6)	abs[(3)–(5)]
Liberia	2000	–1.29	$516	4.30	17	5.59
Mauritania	2000	5.66	$1,380	4.30	17	1.36
Nigeria	2000	17.49	$417	4.30	17	13.19
Pakistan	2000	1.7	$2,053	4.30	17	2.60
Syrian Arab Republic	2000	12.29	$1,271	4.30	17	7.99
Viet Nam	2000	6.18	$1,764	4.30	17	1.88

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

Economy	Decade Start	Actual Annual Growth	Initial Income	Predicted Growth	End Node Number	Absolute Value of Predicted Error
(1)	(2)	(3)	(4)	(5)	(6)	abs[(3)–(5)]
Costa Rica	1960	2.36	$4,314	3.63	4	1.27
Iceland	1960	4.04	$9,736	3.63	4	0.41
Mauritius	1960	1.82	$3,178	3.63	4	1.81
Mexico	1960	3.21	$5,054	3.63	4	0.42
New Zealand	1960	1.51	$12,184	3.63	4	2.12
Panama	1960	6.3	$2,514	3.63	4	2.67
South Africa	1960	3.01	$3,949	3.63	4	0.62
Turkey	1960	3.52	$4,055	3.63	4	0.11
Venezuela, RB	1960	1.93	$7,224	3.63	4	1.70
Zambia	1960	2.45	$3,039	3.63	4	1.18
Colombia	1970	4.85	$4,025	3.63	4	1.22
Costa Rica	1970	2.7	$5,447	3.63	4	0.93
Dominican Republic	1970	4.3	$2,706	3.63	4	0.67
Ecuador	1970	6.18	$2,533	3.63	4	2.55
Guatemala	1970	2.23	$2,889	3.63	4	1.40
Malaysia	1970	7.58	$2,744	3.63	4	3.95
Mauritius	1970	2.26	$3,806	3.63	4	1.37
Mexico	1970	4.39	$6,930	3.63	4	0.76
Panama	1970	2.03	$4,630	3.63	4	1.60
Singapore	1970	7.8	$5,262	3.63	4	4.17
Guatemala	1990	1.68	$3,165	3.63	4	1.95
Chile	1960	3.38	$4,543	1.36	5	2.02
Colombia	1960	2.32	$3,200	1.36	5	0.96
Jamaica	1960	2.41	$4,316	1.36	5	1.05
Jordan	1960	0.19	$2,652	1.36	5	1.17
Trinidad and Tobago	1960	3.66	$6,422	1.36	5	2.30
Brazil	1970	4.59	$3,116	1.36	5	3.23
Chile	1970	0.05	$6,337	1.36	5	1.31
Iran, Islamic Rep.	1970	1.59	$3,028	1.36	5	0.23
Ireland	1970	3.79	$8,126	1.36	5	2.43
Jamaica	1970	–3.69	$5,474	1.36	5	5.05
Jordan	1970	4.16	$2,702	1.36	5	2.80
Peru	1970	0.91	$3,357	1.36	5	0.45
South Africa	1970	2.19	$5,312	1.36	5	0.83
Syrian Arab Republic	1970	–1.35	$2,743	1.36	5	2.71
Trinidad and Tobago	1970	8.74	$9,203	1.36	5	7.38
Turkey	1970	1.48	$5,732	1.36	5	0.12

Economy	Decade Start	Actual Annual Growth	Initial Income	Predicted Growth	End Node Number	Absolute Value of Predicted Error
(1)	(2)	(3)	(4)	(5)	(6)	abs[(3)–(5)]
Venezuela, RB	1970	0.72	$8,745	1.36	5	0.64
Brazil	1980	0.82	$4,880	1.36	5	0.54
Colombia	1980	–0.55	$6,466	1.36	5	1.91
Dominican Republic	1980	–0.65	$4,122	1.36	5	2.01
Gabon	1980	–4.17	$11,876	1.36	5	5.53
Guatemala	1980	–1.29	$3,603	1.36	5	2.65
Iran, Islamic Rep.	1980	–3.06	$3,546	1.36	5	4.42
Israel	1980	2.8	$14,207	1.36	5	1.44
Jamaica	1980	1.21	$3,759	1.36	5	0.15
Jordan	1980	–2.44	$4,061	1.36	5	3.80
Paraguay	1980	0.75	$3,021	1.36	5	0.61
Peru	1980	–1.62	$3,677	1.36	5	2.98
Philippines	1980	1.15	$2,757	1.36	5	0.21
South Africa	1980	–1.77	$6,597	1.36	5	3.13
Thailand	1980	4.45	$2,840	1.36	5	3.09
Turkey	1980	3.12	$6,637	1.36	5	1.76
Venezuela, RB	1980	–1.94	$9,397	1.36	5	3.30
Dominican Republic	1990	4.54	$3,862	1.36	5	3.18
Gabon	1990	–0.53	$7,757	1.36	5	1.89
Iran, Islamic Rep.	1990	9.08	$2,600	1.36	5	7.72
Jamaica	1990	1.51	$4,241	1.36	5	0.15
Jordan	1990	–0.06	$3,172	1.36	5	1.42
Mexico	1990	1.86	$9,102	1.36	5	0.50
Paraguay	1990	–0.31	$3,255	1.36	5	1.67
South Africa	1990	0.69	$5,520	1.36	5	0.67
Venezuela, RB	1990	–2.22	$7,721	1.36	5	3.58
Zimbabwe	1990	1.6	$3,769	1.36	5	0.24
Belize	2000	1.74	$6,154	1.36	5	0.38
Gabon	2000	6.38	$7,354	1.36	5	5.02
Guatemala	2000	1.15	$3,739	1.36	5	0.21
Jordan	2000	5.29	$3,152	1.36	5	3.93
Paraguay	2000	2.97	$3,156	1.36	5	1.61
Saudi Arabia	2000	3.63	$14,519	1.36	5	2.27
Swaziland	2000	–1.32	$4,519	1.36	5	2.68
Sri Lanka	1970	–4.46	$2,560	–1.34	7	3.12
Zambia	1970	–9.3	$3,874	–1.34	7	7.96
Costa Rica	1980	–0.88	$7,107	–1.34	7	0.46
Ecuador	1980	–1.38	$4,616	–1.34	7	0.04
Honduras	1980	–0.68	$2,671	–1.34	7	0.66

Economy	Decade Start	Actual Annual Growth	Initial Income	Predicted Growth	End Node Number	Absolute Value of Predicted Error
(1)	(2)	(3)	(4)	(5)	(6)	abs[(3)–(5)]
Mexico	1980	–1.55	$10,645	–1.34	7	0.21
Ecuador	1990	0.27	$4,017	–1.34	7	1.61
Morocco	1990	–0.46	$3,433	–1.34	7	0.88
Peru	1990	3.68	$3,123	–1.34	7	5.02
Philippines	1990	0.78	$3,090	–1.34	7	2.12
Zimbabwe	2000	–0.79	$4,415	–1.34	7	0.55
Ireland	1960	3.66	$5,670	1.69	8	1.97
Malaysia	1980	0.93	$5,700	1.69	8	0.76
Panama	1980	0	$5,662	1.69	8	1.69
Tunisia	1980	2.4	$3,719	1.69	8	0.71
Honduras	1990	0.3	$2,496	1.69	8	1.39
Tunisia	1990	2.95	$4,713	1.69	8	1.26
Bolivia	2000	3.5	$2,814	1.69	8	1.81
Honduras	2000	1.12	$2,571	1.69	8	0.57
Philippines	2000	0.33	$3,340	1.69	8	1.36
Greece	1960	7.91	$4,010	6.92	11	1.00
Japan	1960	11.4	$3,889	6.92	11	4.49
Portugal	1960	6.41	$3,657	6.92	11	0.51
Spain	1960	6.55	$5,066	6.92	11	0.37
Argentina	1970	1.34	$2,951	6.92	11	5.58
Korea, Rep. of	1980	9.42	$4,340	6.92	11	2.51
Argentina	1990	8.25	$4,604	6.92	11	1.34
Thailand	1990	3.48	$4,392	6.92	11	3.44
China, People's Rep. of	2000	8.07	$3,533	6.92	11	1.16
Peru	2000	6.32	$4,484	6.92	11	0.60
Gabon	1960	7.45	$2,609	4.86	12	2.59
Israel	1960	9.14	$4,893	4.86	12	4.28
Gabon	1970	8.3	$5,352	4.86	12	3.44
Hungary	1970	6.46	$4,940	4.86	12	1.60
Romania	1970	8.26	$2,526	4.86	12	3.40
Argentina	1980	3.16	$3,372	4.86	12	1.70
Mauritius	1980	5.58	$4,759	4.86	12	0.72
Brazil	1990	3.58	$5,297	4.86	12	1.28
Indonesia	1990	1.51	$2,738	4.86	12	3.35
Sri Lanka	1990	2.15	$2,569	4.86	12	2.71
Armenia	2000	6.75	$2,604	4.86	12	1.89
Ecuador	2000	4.66	$4,125	4.86	12	0.20
Egypt, Arab Rep.	2000	1.82	$3,931	4.86	12	3.04
Indonesia	2000	2.48	$3,181	4.86	12	2.38

Economy	Decade Start	Actual Annual Growth	Initial Income	Predicted Growth	End Node Number	Absolute Value of Predicted Error
(1)	(2)	(3)	(4)	(5)	(6)	abs[(3)–(5)]
Jamaica	2000	0.27	$4,929	4.86	12	4.59
Kazakhstan	2000	9.94	$5,440	4.86	12	5.08
Morocco	2000	0.88	$3,278	4.86	12	3.98
Sri Lanka	2000	3.27	$3,178	4.86	12	1.59
Ukraine	2000	6.65	$3,877	4.86	12	1.79
United Kingdom	1960	2.35	$10,313	1.84	15	0.51
Uruguay	1960	0.95	$6,411	1.84	15	0.89
Portugal	1970	2.76	$6,807	1.84	15	0.92
Uruguay	1970	1.86	$7,049	1.84	15	0.02
Chile	1980	0.61	$6,369	1.84	15	1.23
New Zealand	1980	2.25	$14,965	1.84	15	0.41
Portugal	1980	3.62	$8,935	1.84	15	1.78
Uruguay	1980	–0.53	$8,476	1.84	15	2.37
Chile	1990	3.41	$6,770	1.84	15	1.57
Colombia	1990	–0.17	$6,120	1.84	15	2.01
Portugal	1990	4.51	$12,756	1.84	15	2.67
Trinidad and Tobago	1990	0.56	$10,291	1.84	15	1.28
Turkey	1990	1.3	$9,021	1.84	15	0.54
Uruguay	1990	1.79	$8,035	1.84	15	0.05
Argentina	2000	2.76	$10,176	1.84	15	0.92
Botswana	2000	3.46	$8,129	1.84	15	1.62
Colombia	2000	2.63	$6,014	1.84	15	0.79
Dominican Republic	2000	3.62	$6,018	1.84	15	1.78
Mauritius	2000	–1.06	$10,486	1.84	15	2.90
Mexico	2000	1.26	$10,944	1.84	15	0.58
Tunisia	2000	0.8	$6,306	1.84	15	1.04
Italy	1960	5.78	$6,323	3.88	16	1.90
Japan	1970	4.08	$11,451	3.88	16	0.20
Brazil	2000	1.8	$7,528	3.88	16	2.08
Chile	2000	4.31	$9,468	3.88	16	0.43
South Africa	2000	3.15	$5,914	3.88	16	0.73
Thailand	2000	3.39	$6,184	3.88	16	0.49
Trinidad and Tobago	2000	5.49	$10,878	3.88	16	1.61
Turkey	2000	3.04	$10,262	3.88	16	0.84
Austria	1960	3.93	$8,441	4.06	18	0.13
Denmark	1960	4.39	$11,050	4.06	18	0.33
Finland	1960	4.97	$8,069	4.06	18	0.91
France	1960	4.58	$9,274	4.06	18	0.52
Norway	1960	3.94	$10,126	4.06	18	0.12

Economy	Decade Start	Actual Annual Growth	Initial Income	Predicted Growth	End Node Number	Absolute Value of Predicted Error
(1)	(2)	(3)	(4)	(5)	(6)	abs[(3)–(5)]
Austria	1970	2.97	$12,407	4.06	18	1.09
Belgium	1970	3.58	$14,253	4.06	18	0.48
Finland	1970	2.77	$13,099	4.06	18	1.29
France	1970	3.39	$14,513	4.06	18	0.67
Greece	1970	3.3	$8,588	4.06	18	0.76
Iceland	1970	5.3	$14,467	4.06	18	1.24
Norway	1970	3.85	$14,900	4.06	18	0.21
Spain	1970	3.06	$9,549	4.06	18	1.00
Spain	1980	1.93	$12,910	4.06	18	2.13
Korea, Rep. of	1990	6.26	$10,679	4.06	18	2.20
Malaysia	1990	4.67	$6,251	4.06	18	0.61
Romania	1990	0.91	$6,057	4.06	18	3.15
Bulgaria	2000	5.47	$7,372	4.06	18	1.41
Romania	2000	7.15	$6,633	4.06	18	3.09
Venezuela, RB	2000	4.83	$6,170	4.06	18	0.77
Australia	1960	3.14	$12,290	2.84	20	0.30
Canada	1960	3.17	$11,758	2.84	20	0.33
Netherlands	1960	4.45	$9,615	2.84	20	1.61
Israel	1970	1.94	$11,729	2.84	20	0.90
Italy	1970	4.68	$11,090	2.84	20	1.84
Netherlands	1970	2.84	$14,861	2.84	20	0.00
New Zealand	1970	0.56	$14,158	2.84	20	2.28
United Kingdom	1970	2.78	$13,005	2.84	20	0.06
Greece	1980	1.73	$11,881	2.84	20	1.11
Hungary	1980	2.05	$9,239	2.84	20	0.79
Ireland	1980	3.25	$11,792	2.84	20	0.41
Romania	1980	0.81	$5,586	2.84	20	2.03
Costa Rica	1990	2.66	$6,507	2.84	20	0.18
Panama	1990	3.28	$5,661	2.84	20	0.44
Costa Rica	2000	1.65	$8,458	2.84	20	1.19
Iran, Islamic Rep.	2000	6.27	$6,202	2.84	20	3.43
Malaysia	2000	2.8	$9,866	2.84	20	0.04
Panama	2000	3.79	$7,820	2.84	20	0.95
Uruguay	2000	2.18	$9,591	2.84	20	0.66
Sweden	1960	3.8	$11,377	4.08	21	0.28
Cyprus	1980	5.29	$10,199	4.08	21	1.21
Malta	1980	3.02	$8,530	4.08	21	1.06
Singapore	1980	5.1	$11,147	4.08	21	1.02
Bulgaria	1990	–0.36	$7,646	4.08	21	4.44

Economy	Decade Start	Actual Annual Growth	Initial Income	Predicted Growth	End Node Number	Absolute Value of Predicted Error
(1)	(2)	(3)	(4)	(5)	(6)	abs[(3)–(5)]
Greece	1990	3.69	$14,099	4.08	21	0.39
Hungary	1990	1.95	$11,314	4.08	21	2.13
Malta	1990	6.03	$11,488	4.08	21	1.95
Mauritius	1990	2.5	$8,194	4.08	21	1.58
Poland	1990	5.34	$7,114	4.08	21	1.26
Croatia	2000	3.64	$12,016	4.08	21	0.44
Estonia	2000	5.16	$11,340	4.08	21	1.08
Hungary	2000	3.17	$13,727	4.08	21	0.91
Latvia	2000	4.77	$9,350	4.08	21	0.69
Lithuania	2000	4.76	$10,286	4.08	21	0.68
Poland	2000	4.11	$11,967	4.08	21	0.03
Russian Federation	2000	6.42	$9,256	4.08	21	2.34
Slovak Republic	2000	5.09	$12,800	4.08	21	1.01

Figure A1. Income Transition from 1980 to 2011