



Munich Personal RePEc Archive

The Stability of Sustainable Development Path and Institutions: Evidence from Genuine Savings Indicators

Sato, Masayuki and Samreth, Sovannroeun and Sasaki,
Kengo

Kobe University, Saitama University, Nagoya Gakuin University

9 August 2013

Online at <https://mpra.ub.uni-muenchen.de/48983/>
MPRA Paper No. 48983, posted 10 Aug 2013 08:07 UTC

The Stability of Sustainable Development Path and Institutions: Evidence from Genuine Savings Indicators^{*}

Masayuki Sato[†]

Graduate School of Human Development and Environment, Kobe University, Japan

Sovannroeun Samreth

Faculty of Liberal Arts, Saitama University, Japan

Kengo Sasaki

Department of Economics, Nagoya Gakuin University, Japan

Abstract

This paper investigates institutional factors affecting the performance of genuine savings (GS), which is often used in assessing sustainable development, adopting a model of autoregressive conditional heteroscedasticity in mean. We pay particular attention to the contribution of institutions to decrease the volatility level of the GS path. Using GS data from the World Bank's World Development Indicators, and institutional data in the International Country Risk Guide, the estimation results show that there are two ways, through which institutions affecting GS performance. First, the high quality of the institutions enhance GS level directly. Second, the high quality of institutions enhance the GS level via stabilizing the volatility of the GS path. Considering both effect in their totality, institutional improvement plays an important role in realizing a sustainable development path.

Key words: Sustainable Development; Genuine Savings; Volatility; Institution

JEL classifications: Q01; O43; Q56

^{*} We would like to thank Catia Cialani, Shunsuke Managi, Ayumi Onuma and Kazuhiro Ueta for their helpful comments. The earlier versions of this paper were presented at the European Association of Environmental and Resource Economists in 2011 and at the 13th International Convention of the East Asian Economic Association in 2012.

[†] Corresponding author. Address: 3-11 Tsurukabuto, Nada -ku, Kobe 659-8501, Japan.

Email: msat@port.kobe-u.ac.jp

1. Introduction

One of the economic ideas for assessing the sustainability of development is to observe “genuine savings (hereinafter, GS).” The GS concept, first proposed by Pearce and Atkinson (1993), is a “capital approach” that captures the depletion of capital stock, usually overlooked in the GDP.¹ This concept is useful for capturing economic and environmental variations in total terms. Various empirical applications using the GS indicator has been utilized in prominent studies, such as that of Hamilton and Atkinson (2006). The GS-based sustainability condition is conceptually based on the definition found in the Brundtland report (World Commission, 1987) and can be simplified as “non-declining well-being for the future”(Arrow et al., 2003). Based on this definition, a development is judged to be sustainable if and only if its productive base, which is the source of well-being, is maintained at all times. This productive base called “inclusive wealth” includes not only man-made capital but also all possible sources of human well-being, such as human capital and natural capital. The maintainance of this inclusive wealth implies that a future generation will be to realize at least the same level of well-being compared to that experienced by the current generation.²

During the past several decades, many studies have applied this indicator when examining a country’s sustainability (see Hamilton and Clemens, 1999; Arrow *et al.*, 2004, etc.). However, there is little discussion on the shape of the path, namely what kind of GS path is more desirable than another. Figure 1 demonstrates that there are

¹ This concept is classified as “weak sustainability,” which admits there is substitutability among the different capitals. For details on strong and weak sustainability, see Neumayer (2000).

² In researches related to GS studies, the change of inclusive stock is purposefully addressed using different terminologies, such as “inclusive investment” (Dasgupta, 2007) and “adjusted net savings” (World Bank). A recent research project developed the inclusive wealth index and stressed the difference between this concept and GS in its theoretical assumptions and empirical techniques (see UNU-IHDP and UNEP, 2012). In this paper, we focus on the GS path and utilize the data from the World Bank due to its data richness.

various shapes of the GS path, as provided from GS data in the World Bank's World Development Indicators (WDI) used in the previous studies.

[Figure 1 here]

Figure 1 illustrates the average GS level, the paths of actual value, and a Hodrick–Prescott(HP) filter-based smoothed value for GS. The average value of GS has typically been used to judge the sustainability of a country in many of the previous studies, such as Hamilton and Clemens (1999) and Arrow *et al.* (2004). However, as Figure 1 shows, for some countries, the shapes of their GS paths are quite different although their GS averages are indeed very similar. For example, the GS in Albania, the United States, and the United Kingdom shows a similar average, but its shapes are quite different. While the United Kingdom's GS is very stable, Albania's GS is quite volatile and experiences negative value. Another remarkable difference is that China's GS is more volatile than that for Japan and Sweden. Figure 1 also shows the future risk in 50 years of violating the condition of sustainable development ($GS \geq 0$), calculated in Sato *et al.* (2012), except for Albania.³ The probabilities of experiencing a negative GS value are quite different in the selected countries. This difference implies that even if GS averages are almost the same, the evaluation of sustainability may be different in different countries.

Given the above discussion, judging sustainability in a country should not be based only on the average value of GS. On this point, volatility has become an important issue in terms of economic growth and development. Many studies on whether volatility is

³ Based on a simulation, Sato *et al.* (2012) calculate the probability that the GS in a country will experience negative value in 50 years.

good for growth or not are available. On the one hand, studies like Mirman (1971) suggest that volatility can boost growth through precautionary savings. On the other hand, studies like Bernanke (1983) have shown that growth volatility produces a lower growth rate over time. In a recent study that considers both potential effects of volatility, van der Ploeg and Poelhekke (2009) find that the financial sector plays an important role in alleviating the baneful effect of volatility in resource- exporting countries.

It is likely that GS volatility is also important in the study of sustainable development when we define sustainable development as non-negative GS for all points of time, as volatility may increase the risk of experiencing negative GS. As indicated by Arrow *et al.* (2003), the shape of a GS path is considered to be determined by a “resource allocation mechanism.” A stable and non-negative GS should be realized if the allocation mechanism works well and the established policy for sustainable development is properly conducted. If the allocation is failing, however, the wealth in the noted country is seriously impacted, and the performance of GS will significantly deteriorate. From this analysis , it is reasonable to consider that the determinants of a stable path of GS in each country may depend on its individual institutional factors that affect resource management.

There are also researches available on the relationship between institutions and the volatility of an economic growth path. Acemogulu *et al.* (2003) hypothesized and provided evidence that shows that weak institutions will lead to a high volatility of growth. Yang (2008) finds that by taking into account ethnic diversity, democracy lowers growth volatility in heterogeneous ethnic countries. These factors can also be considered important in the context of sustainable development. In this regard, Dietz *et al.* (2007) analyse the linkage between GS level and corruption, but they do not

consider the GS volatility effect. However, based on the above discussion, it is expected that the effects of volatility may also be important in the context of GS. In a recent study on GS volatility, Sato *et al.* (2012) calculate the volatility of GS based on time-series data and conduct a simulation to calculate the probability of experiencing a negative GS value within 50 years in various countries. The results show that even if their GS averages are similar, countries whose GS paths are relatively volatile tend to have a higher probability of experiencing a negative GS value, thus suggesting a violation of the GS-based sustainability condition. However, Sato *et al.* (2012) did not investigate the specific factors that affect GS volatility.

From this discussion, it appears that to analyze sustainable development appropriately using the GS indicator, it is also important to take GS volatility into account. Moreover, it is reasonably clear that GS volatility may be affected by the institutions in each country. In this paper, we simultaneously examine the effect of institutions on GS volatility and the impact of volatility on GS performance using the panel data from 63 countries. We adopt the autoregressive conditional heteroscedasticity in mean (ARCH-M) as our estimation methodology.

The remainder of the paper is structured as follows. Section 2 presents the estimation methodology; Section 3 explains the data used for the estimation; Section 4 provides the estimation results and discussion; and Section 5 presents concluding remarks.

2. Estimation Methodology

As already discussed, this paper defines sustainable development as non-declining inclusive wealth, represented by W in Equation (1)

$$W_t = KM_t + KH_t + KN_t, \quad (1)$$

where KM_t is manmade capital, KH_t is human capital, and KN_t is natural capital, all of which are evaluated by their accounting prices (shadow prices).⁴ The time differentiation for W is called genuine savings (GS), and the sustainability condition requires that GS is always non-negative as follows:

$$GS_t \equiv \frac{dW_t}{dt} = \frac{dKM_t}{dt} + \frac{dKH_t}{dt} + \frac{dKN_t}{dt} \geq 0, \quad \text{for all } t \quad (2)$$

To investigate the relationships among institutions, GS, and its volatility, we follow the estimation framework adopted by Ramey and Ramey (1995) and van der Ploeg and Poelhekke (2009). They apply the ARCH-M methodology developed by Engel *et al.* (1987). The ARCH-M model is a modification of the ARCH model suggested by Engle (1982). It incorporates the variance in the mean equation. The mean and variance equations are then constructed as follows:

$$\log(GS_{it}) = c_1 + \beta_1 \sigma_{it}^2 + M_{it} \beta + X_{it} \varphi + \varepsilon_{it}, \quad (3)$$

$$\varepsilon_{it} \sim N(0, \sigma_{it}^2), \quad (4)$$

$$\sigma_{it}^2 = \exp(c_2 + X_{it} \kappa + Z_{it} \gamma) + \phi_1 \sigma_{t-1}^2 + \phi_2 \sigma_{t-2}^2 + \eta_{it}, \quad (5)$$

⁴ Dasgupta (2004) also includes knowledge capital in equation (1). However, as mentioned in Section 3, our data do not include knowledge capital due to the fact that the available database for GS is based on only three types of capital (manmade capital, human capital, and natural capital) in equation (1).

where GS_{it} represents the transformed genuine savings in country i . Since the original value of genuine savings can have a non-positive value, it is transformed as shown below to be able to take a logarithm.

$$GS_{it} = gs_{it} + 1, \quad (6)$$

where gs_{it} is the original data of genuine savings in country i . σ^2 is the variance of genuine savings, reflecting volatility, and t is the time index. M is the vector of control variables, which appear only in the mean equation (3). It contains age dependency (*age_dep*) and the urban population rate in total population (*urban*). X is the vector of the variables, which are expected to have impacts on both GS and its volatility. For these variables, we mainly focus on institutions (*institution*). Moreover, X includes other variables, such as per capita GDP growth (*ggdp*), inflation rate (*inflation*), trade openness (*trade*), and government size (*gov_size*), proxied by the share of government expenditures in the GDP. These variables are chosen following Dietz *et al.* (2007). Z is a vector representing a set of variables that only have an impact on GS variance and contains the square of per capita GDP growth ($ggdp^2$). Therefore, they are included only in equation (5). These variables affect GS indirectly through its variance.

In sum, in this paper, institutions are assumed to affect GS through two channels. First, higher-quality institutions may contribute to proper resource allocation. This allocation results in a higher GS performance (by the same token, lower-quality institutions may result in a lower GS). Secondly, higher-quality institutions may help to

stabilize a development path, which would imply that if the coefficient of volatility, β_1 , is negative, then a decrease in volatility may contribute to a higher level of GS value.

Figure 2 illustrates the effect of institutions on GS.

[Figure 2 here]

We also include two regional dummies, a Middle East/North Africa dummy (*region_dummy1*) and a sub-Saharan African dummy (*region_dummy2*), in both the mean and variance equations.⁵ The rationales underlying this inclusion are the following. Incorporating the world's resource-rich region, the Middle East/North Africa dummy, allows us to observe how the specific characteristics of this region impact GS performance. For sub-Saharan Africa, since this region has generally suffered from a slow economic growth over recent decades, it is natural to consider that the performance of capital accumulation is relatively poor in the region. Therefore, its dummy variable is incorporated to control for this specific characteristic.

From the discussion noted above, the mean and variance estimation equations for our ARCH-M model can be rewritten as

$$\begin{aligned} \log(GS_{i,t}) = & c_1 + \beta_1 \sigma_{i,t}^2 + \beta_2 \text{ggdp}_{i,t} + \beta_3 \text{age_dep}_{i,t} + \beta_4 \text{urban}_{i,t} \\ & + \beta_5 \text{institutions}_{i,t} + \beta_6 \text{inflation}_{i,t} + \beta_7 \text{trade}_{i,t} \\ & + \beta_8 \text{gov_size}_{i,t} + \beta_9 \text{region_dummy1} \\ & + \beta_{10} \text{region_dummy2} + \varepsilon_{i,t} \end{aligned} \quad (7)$$

$$\varepsilon_{it} \sim N(0, \sigma_{it}^2) \quad (8)$$

⁵ Region specification is based on the World Bank's classification.

$$\begin{aligned} \sigma_{i,t}^2 = & \exp(c_2 + \gamma_1 gdp_{i,t} + \gamma_2 gdp_{i,t}^2 + \gamma_3 institutions_{i,t} + \gamma_4 inflation_{i,t} \\ & + \gamma_5 trade_{i,t} + \gamma_6 gov_size_{i,t} + \gamma_7 region_dummy1 \\ & + \gamma_8 region_dummy2) + \phi_1 \sigma_{i,t-1}^2 + \phi_2 \sigma_{i,t-2}^2 + \eta_{i,t} \end{aligned} \quad (9)$$

As discussed in Section 1, the main purpose of this paper is to confirm whether or not the GS value in the LHS of the mean equation (7) is negatively affected by its own volatility (variance). As economic growth indicates an increase in investment resources, it is natural to anticipate that economic growth also contributes to the accumulation of a productive base, leading, therefore, to the expectation that the sign of per capita GDP growth in the mean equation (7) is positive ($\beta_2 > 0$). However, highly rapid economic growth may cause GS volatility. Hence, the expected sign for the square of per capita GDP growth in the variance equation (9) is expected to be positive ($\gamma_2 > 0$). For trade openness, it may or may not contribute to an increase in the GS level itself, but it is certainly a source of GS volatility, as discussed in van der Ploeg and Poelhekke (2009). Therefore, its expected sign in the variance equation is positive ($\gamma_5 > 0$). Government size also may or may not have a positive impact on GS level, but it is expected to help stabilize the development path due to the basic “stabilizing function” of the government. Therefore, the expected sign of its estimated coefficient in the variance equation is negative ($\gamma_6 < 0$). The signs of the estimated coefficients of age dependency, urban population rate, and inflation are expected to be negative in the mean equation (7) ($\beta_3 < 0$, $\beta_4 < 0$, and $\beta_6 < 0$). In the variance equation (9), the sign of inflation is expected to be positive ($\gamma_4 > 0$).

Finally, and most importantly, the institutional variables are expected to contribute to an increase in GS and a decrease in GS volatility. This finding implies that the sign of an institutional variable is expected to be positive in the mean equation (7) ($\beta_5 > 0$) and

negative in a variance equation (9) ($\gamma_3 < 0$). For a resource-abundant region, such as the oil exporting countries of Middle East/North Africa, the sign of its estimated coefficient (β_9) in the mean equation (7) can be either negative or positive, depending on how the countries in the region manage their rich resources. If the revenue earned from resource exporting is sufficiently invested in other capital (man-made or human capital) stocks to compensate for the depletion of natural capital, β_9 is expected to be positive. Otherwise, it is expected to be negative. As for the estimated coefficient for the Middle East/North Africa regional dummy (γ_7) in a variance equation (9), its sign is expected to be positive if the resources are indiscriminately exploited and negative if they are appropriately extracted.

For the sub-Saharan African dummy, as mentioned above, it is included to capture that region's slow economic growth over recent decades. This poor growth performance may have a negative impact on capital accumulation. Therefore, the signs of its estimated coefficients are expected to be negative in the mean equation ($\beta_{10} < 0$) and positive in the variance equation ($\gamma_8 > 0$), respectively.

To examine how institutional factors affect the impacts of trade openness and government size on GS performance, the interaction terms between trade openness and institutions and between government size and institutions are added to the estimation equations. Furthermore, the interaction terms between per capita GDP and institutions are also taken into account for investigating how institutions affect GS performance, given different levels of development. The mean and variance equations with each interaction term can thus be written as follows.

$$\begin{aligned}
\log(GS_{i,t}) = & c_3 + \beta_{11}\sigma_{2i,t}^2 + \beta_{12}gdp_{i,t} + \beta_{13}age_dep_{i,t} + \beta_{14}urban_{i,t} \\
& + \beta_{15}institutions_{i,t} + \beta_{16}inflation_{i,t} + \beta_{17}trade_{i,t} \\
& + \beta_{18}gov_size_{i,t} + \beta_{19}(W_{i,t})*(institutions) \\
& + \beta_{20}region_dummy1 + \beta_{21}region_dummy2 + \varepsilon_{1i,t}
\end{aligned} \tag{10}$$

$$\varepsilon_{it} \sim N(0, \sigma_{it}^2) \tag{11}$$

$$\begin{aligned}
\sigma_{2i,t}^2 = & \exp(c_4 + \gamma_9gdp_{i,t} + \gamma_{10}gdp_{i,t}^2 + \gamma_{11}institutions_{i,t} + \gamma_{12}inflation_{i,t} \\
& + \gamma_{13}trade_{i,t} + \gamma_{14}gov_size_{i,t} + \gamma_{15}(W_{i,t})*(institutions) \\
& + \gamma_{16}region_dummy1 + \gamma_{17}region_dummy2 \\
& + \phi_3\sigma_{2i,t-1}^2 + \phi_4\sigma_{2i,t-2}^2 + \eta_{1i,t}
\end{aligned} \tag{12}$$

where W is per capita GDP, trade openness, or government expenditures.

3. Data

The GS data for our study are taken from World Development Indicators (WDI) (2010) released by the World Bank.⁶ It is worth noting that, as stressed by van der Ploeg (2011), the World Bank's "adjusted net savings (ANS)" possibly overestimates genuine savings, especially in resource-rich countries. However, we employ WDI's ANS data as the GS for our analysis, given the fact that it is the most reliable and available data source.

WDI provides GS data calculated by three types of capital: The sum of manmade capital investment (net national savings; $\frac{dKM_t}{dt}$), human capital investment (education expenditures; $\frac{dKH_t}{dt}$), and degradation of natural resources (energy depletion, mineral depletion, forest depletion, and CO₂ emissions; $\frac{dKN_t}{dt}$). Other variables, such as economic growth per capita, urban population rate, age dependency, inflation rate, trade,

⁶ Available at <http://databank.worldbank.org/>

and government expenditure, are also taken from the WDI (2010).

With respect to institutional variables, the data were obtained from the International Country Risk Guide (ICRG) provided by the Political Risk Service. The 12 institutional variables of ICRG employed for our analysis include: (1) Bureaucracy Quality, (2) Corruption, (3) Democratic Accountability, (4) Ethnic Tension, (5) External Conflict, (6) Government Stability, (7) Internal Conflict, (8) Investment Profile, (9) Law and Order, (10) Military in Politics, (11) Religious Tension, and (12) Socio-economic Condition. Appendix B provides a brief explanation of these institutional variables.

A summary of the definitions of the variables used and their data sources is provided in Table A1 in Appendix A. Sixty-three countries were utilized for the analysis as a balanced panel. The country list is provided in Table A2 in Appendix A. Following Busse and Hefeker (2007), we introduce institutional variables into econometric models one by one to avoid the multicollinearity problem, since these variables are strongly related to each other as shown in the correlation matrix in Table 1.

Using the above two databases, we set up a dataset for analysis. The sample period for our analysis runs from 1984 to 2008 based on the data availability of all the variables in our study.

[Table 1 here]

4. Estimation Results and Discussion

We adopted the ARCH-M model for our estimation, in which the mean equations (7) and (10) and the variance equations (9) and (12) are simultaneously estimated. Table 2 shows the estimation results for four institution variables, namely, Bureaucracy Quality,

Corruption, Democratic Accountability, and Law and Order.⁷ Columns (1) to (16) illustrate the results for these four institutional variables as follows: Columns (1) to (4) for Bureaucracy Quality; columns (5) to (8) for Corruption; columns (9) to (12) for Democratic Accountability; and columns (13) to (16) for Law and Order

[Table 2 here]

From the table, most of the coefficients for the variables in consideration are statistically significant and have correct signs. Specifically, all the estimated coefficients of GS volatility (σ^2) in the mean equations (7) and (10) are significantly negative. As expected, most of the institutional variables have significantly positive impacts on GS value. Specifically, for institutional variables, such as bureaucracy quality, corruption, democratic accountability, and law and order, we confirm that they have two-way impacts on sustainable development. One is a direct effect on the mean equations (7) and (10); the other via stabilization of GS volatility in the variance equations (9) and (12). This finding could be interpreted as their contributing to the stabilization of GS volatility. In sum, our ARCH-M estimation provides sufficient evidence to support the finding that the quality of institutions plays an important role in improving and stabilizing sustainable development. The total effects of institutions on GS performance can be calculated based on their indirect effects in the variance equations and their direct effects in the mean equation. Using the country average of required variables for 2008, the total effects of corruption, for example, are calculated as 0.0035. It is noteworthy

⁷ Only the results for these four institutional variables are reported in Table 2 to save space. For the results for the other eight institutional variables, see Table C1 in Appendix C.

also that the total effect for genuine savings is larger than the direct effect of improvement of corruption, thus reflecting the stabilization of the GS-development path.⁸

The estimation results in Table 2 further indicate that an increase in age dependency (*age_dep*) and urban population rate (*urban*) leads to a lower GS level. From columns (1), (5), (9), and (13), trade openness (*trade*) could increase the GS level, but that factor also has an indirect effect on causing GS volatility. The total effects can be calculated in the same way as the case of institution. For example, the total effect of trade openness is 0.033 for the case of corruption.⁹ It is also noteworthy that the total effect of trade openness is smaller than its direct effect, thus reflecting a volatilizing GS-development path. This finding means that it is an overestimation if only focusing on the direct effect of trade openness.

To examine how institutions affect the impact of trade on GS, we incorporate the interaction term between trade and institutions into the estimation equations. These results are shown in columns (3), (7), (11), and (15). The results in the mean equation show that, for countries with a low level of institutional quality, the effects of institutions on the increasing impact of trade on the GS level is relatively large. This finding indicates the importance of institutional improvement on enhancing the direct impact of trade on the GS level, especially in countries with a poor quality of

⁸ This is calculated from (7) and (9) as

$$\frac{\partial \log GS}{\partial X} = \beta_1 \gamma_3 e^{c_2 + \gamma_3 X + \gamma Z} + \beta_5$$

where X is institutional variables, i.e., corruption; β_5 is a direct effect, i.e., the coefficient of institutions in the mean regression; γ is a coefficient vector, $(\gamma_1, \gamma_2, \gamma_4, \gamma_5, \gamma_6, \gamma_7, \gamma_8)$; Z is the variable vector, $(ggdp, ggdp^2, inflation, trade, gov_size, region_dummy1, region_dummy2)$. For other institutional variables, we can calculate in a similar procedure.

⁹ Although there are 12 institutional variables, we selected one institutional variable when calculating the total effect of control variables. We also calculate the total effect of trade openness for other 11 institutional variables and find that the total effect is smaller than its direct effect.

institutions. Furthermore, the results for the variance equation show that although trade leads to the volatility of GS, a better quality of institutions helps to reduce this volatility. Therefore, an improvement of institutions reduces the negative indirect impact of trade on the GS level.

For government expenditures (*gov_size*), the results in columns (5), (9), and (13) show that it helps to improve the GS performance from the results of the mean equation. In the variance equation, however, it seems to have an effect on stabilizing the GS volatility in column (1). In general, compared to other variables, government expenditures show an ambiguous effect on GS. Given these results, the impact of government size may depend on the type of the government. A more profound investigation on the effect of government size will be the subject for future research. For columns (2), (6), (10), and (14) where the interaction terms between per capita GDP and institutions are included, in the mean equation, the results indicate that the effects of institutions on GS level is relatively high at the lower level of per capital GDP. This finding implies that in countries with a lower level of development, institutions have higher impacts on GS level. From the variance equation in the same columns, the results show that institutional quality helps stabilize the GS volatility, and the stabilization effect is stronger in a country with a higher level of development. These results should not be surprising, given the fact that countries with a higher level of development have more efficient governments.

Regarding the effect of per capita GDP growth rate on GS volatility, from the estimation results in the variance equation, the estimated coefficients of per capita GDP growth rate are significantly negative, while the estimated coefficients of their squared terms are significantly positive. This result indicates the U-shaped effect of economic

growth on GS volatility, implying the existence of a turning point for this effect. We report this turning-point level for per capita GDP growth rate in Table 2. The growth rate below (above) this turning point has a negative (positive) impact on GS volatility. However, because the turning point is generally very high, and given the fact that the average growth rate of an economy rarely exceeds 10 percent, we can conclude the reduction impact of growth rate on GS volatility from our findings.

5. Concluding Remarks

Using the autoregressive conditional heteroscedasticity in the mean (ARCH-M) model, this paper investigates two effects of institutional quality on GS performance. One is a direct effect, and the other is an indirect effect determined through a volatility channel. From the estimation results, we find that GS volatility could depress GS performance. This finding implies that the previous studies that focus only on the direct effect could be an over- or under-evaluation of sustainability. It is important to take into account the stability of the GS development path. On this point, our study focuses on the role of institutions as factors that affect the shape of the development path. Therefore, we examine whether institutional variables do affect the volatility of the GS path. Our results show that better institutions overall contribute not only to improving GS performance but also to stabilizing its volatility. In other words, a high quality of institutions directly boosts GS level and indirectly contributes to GS performance via volatility stabilization. It is often argued herein that proper institutional quality is needed for sustainable development. In this paper, we provide actual quantitative evidence that supports this argument.

Our findings suggest that judging sustainable development in a country based only

on a GS average is insufficient. It is necessary to judge the GS path as a whole from a broader viewpoint that includes institutional factors or other significant factors that affect GS or the volatility of its path. In reality, the shapes of a GS path are quite different from country to country, and its volatility is certainly important in addressing such differences. In this paper, we provide a research framework that takes into account institutional factors as a main source of that volatility and thus assesses sustainability more precisely. It is worth noting as well that the performance of institutions is difficult to measure. At present, the twelve institutional variables published by ICRG, which are used in this paper, appear to be the best available dataset. However, when better institutional variables are available, the future research on sustainability using them will be worth conducting.

Appendix A

Table A1: Variable definition and data source

| Variable | Definition | Data Source |
|---|---|---|
| I. Dependent Variable | | |
| Genuine savings (GS) | The share of “Adjusted Net Savings” in GNI. | World Development Indicators (2010) |
| II. Independent Variable | | |
| Per capita GDP growth rate (<i>ggdp</i>)* | The annual growth rate of per capita GDP. | World Development Indicators (2010) |
| Age dependency (<i>age_dep</i>) | The share of dependents (people younger than 15 or older than 64) to the working-age population (people ages 15-64) | World Development Indicators (2010) |
| Urban population rate (<i>urban</i>) | The share of urban population in total population. The data of urban population and total population for calculating this rate is drawn from World Development Indicators (2010). | World Development Indicators (2010) |
| Inflation rate (<i>inflation</i>)* | The annual rate of inflation calculated from GDP deflator. | World Development Indicators (2010) |
| Trade openness (<i>trade</i>)* | The share of the sum of export and import of goods and services in GDP. | World Development Indicators (2010) |
| Government Expenditure (<i>gov_size</i>)* | The share of general government final consumption expenditure in GDP. | World Development Indicators (2010) |
| Institutional variables* : | | |
| (1) Bureaucracy Quality | Score: 0 (lowest) to 4 (highest) | International Country Risk Guide (2009) |
| (2) Corruption | Score: 0 (lowest) to 6 (highest) | International Country Risk Guide (2009) |
| (3) Democratic Accountability | Score: 0 (lowest) to 6 (highest) | International Country Risk Guide (2009) |
| (4) Ethnic Tension | Score: 0 (lowest) to 6 (highest) | International Country Risk Guide (2009) |
| (5) External Conflict | Score: 0 (lowest) to 12 (highest) | International Country Risk Guide (2009) |
| (6) Government Stability | Score: 0 (lowest) to 12 (highest) | International Country Risk Guide (2009) |
| (7) Internal Conflict | Score: 0 (lowest) to 12 (highest) | International Country Risk Guide (2009) |
| (8) Investment Profile | Score: 0 (lowest) to 12 (highest) | International Country Risk Guide (2009) |
| (9) Law and Order | Score: 0 (lowest) to 6 (highest) | International Country Risk Guide (2009) |
| (10) Military in Politics | Score: 0 (lowest) to 6 (highest) | International Country Risk Guide (2009) |
| (11) Religious Tension | Score: 0 (lowest) to 6 (highest) | International Country Risk Guide (2009) |
| (12) Socio-economic Condition | Score: 0 (lowest) to 12 (highest) | International Country Risk Guide (2009) |

Note: “*” indicates the variables that are included in both mean and variance equation in ARCH-M model.

Table A2: List of countries

| | | | |
|-----|--------------------|-----|---------------------|
| 1. | Albania | 33. | Jordan |
| 2. | Australia | 34. | Kenya |
| 3. | Austria | 35. | Mexico |
| 4. | Bahrain | 36. | Morocco |
| 5. | Bangladesh | 37. | Netherlands |
| 6. | Bolivia | 38. | Norway |
| 7. | Brazil | 39. | Pakistan |
| 8. | Bulgaria | 40. | Panama |
| 9. | Canada | 41. | Papua New Guinea |
| 10. | Chile | 42. | Paraguay |
| 11. | China | 43. | Peru |
| 12. | Congo, DR | 44. | Philippines |
| 13. | Costa Rica | 45. | Portugal |
| 14. | Cote d'Ivoire | 46. | Saudi Arabia |
| 15. | Denmark | 47. | South Africa |
| 16. | Dominican Republic | 48. | South Korea |
| 17. | Ecuador | 49. | Spain |
| 18. | Egypt | 50. | Sri Lanka |
| 19. | Finland | 51. | Sudan |
| 20. | France | 52. | Sweden |
| 21. | Gabon | 53. | Syria |
| 22. | Ghana | 54. | Thailand |
| 23. | Greece | 55. | Trinidad and Tobago |
| 24. | Guatemala | 56. | Tunisia |
| 25. | Honduras | 57. | Turkey |
| 26. | Hungary | 58. | Uganda |
| 27. | India | 59. | United Kingdom |
| 28. | Indonesia | 60. | United States |
| 29. | Ireland | 61. | Uruguay |
| 30. | Israel | 62. | Venezuela |
| 31. | Italy | 63. | Zambia |
| 32. | Japan | | |

Appendix B

Explanation of institutional variables:

(See http://www.prsgroup.com/ICRG_Methodology.aspx for more detailed explanation)

- (1) Bureaucracy Quality relates the institutional strength and quality of bureaucracy. High score on this indicator implies the high autonomy of bureaucracy from political pressure and its strength and expertise to govern without drastic changes in policy or interruptions in government services.
- (2) Corruption causes distortion in economic and financial environments. It also reduces the efficiency of government and business and causes instability in the political process. Less corrupt countries receive a high score.
- (3) Democratic Accountability expresses how responsive government is to its people. A high score means that the government type of the country is highly responsive.
- (4) Ethnic Tension assesses the degree of tension within a country attributable to racial, nationality, or language divisions. A high score on this indicator means that the tensions are minimal, even though such differences still exist.
- (5) External Conflict is the measure of the risk to the incumbent government from foreign action. Countries with low risk receive a high score.
- (6) Government Stability is the assessment of the government's ability to carry out its declared programs and to stay in office. Countries with a strong government receive a high score.
- (7) Internal Conflict assesses the political violence in the country and its actual or potential impact on governance. Countries receive a high score when there is no armed or civil opposition to the government and the government does not indulge in

arbitrary violence against its own people.

- (8)** Investment Profile assesses the risks of investment that are not covered by other political, economic and financial risk components, such as contract viability, profits repatriation and payment delays. A high score means low risks.
- (9)** Law and Order assesses both the strength and impartiality of the legal system and popular observance of the law. Countries with a well-working judicial system receive a high score.
- (10)** Military in Politics reports the degree to which the military, which is not elected, participates in government. The military in government tends to produce some kinds of risk in the long run. Low ratings indicate a greater degree of military participation in politics and a higher level of political risk.
- (11)** Religious tension may be caused by the domination of society and/or governance by a single religious group that seeks to replace civil law with religious law and to exclude other religions from the political and/or social process. A high score means a low tension.
- (12)** Socio-economic condition assesses the pressures at work in society that could constrain government action or fuel social dissatisfaction relating to unemployment, consumer confidence and poverty. A high score means that the society is free from such pressures.

Appendix C

Table C1: GS and its volatility (ARCH-M estimation)
Dependent variable: log(GS)

| Sample period: 1984-2008 | Ethnic Tension (1) | Ethnic Tension (2) | Ethnic Tension (3) | Ethnic Tension (4) |
|---|--------------------------|--------------------------|--------------------------|--------------------------|
| GS volatility (σ^2) | -0.9021*** (0.2583) | -0.8402*** (0.2701) | -0.8315*** (0.2517) | -0.8796*** (0.2717) |
| Per capita GDP growth rate (ggdp) | 0.2029*** (0.0219) | 0.2089*** (0.0227) | 0.2181*** (0.0223) | 0.2128*** (0.0212) |
| Age dependency (age_dep) | -0.0931*** (0.0080) | -0.0869*** (0.0087) | -0.0912*** (0.0075) | -0.0915*** (0.0081) |
| Urban population rate (urban) | -0.1241*** (0.0048) | -0.1269*** (0.0050) | -0.1172*** (0.0046) | -0.1206*** (0.0048) |
| Institutional factors (institution) | 0.0011* (0.0007) | 0.0010 (0.0007) | -0.0046*** (0.0013) | -0.0008 (0.0017) |
| Inflation rate (inflation) | -0.0002 (0.0003) | -0.0001 (0.0003) | -0.0001 (0.0003) | -0.0001 (0.0003) |
| Trade openness (trade) | 0.0408*** (0.0024) | 0.0374*** (0.0022) | -0.0059 (0.0108) | 0.0410*** (0.0024) |
| Government expenditure (gov_size) | 0.1683*** (0.0186) | 0.1427*** (0.0203) | 0.1717*** (0.0179) | 0.1067** (0.0525) |
| (Per capita GDP)*(institutional factors) | | 0.0001*** (0.0000) | | |
| (Trade openness)*(institutional factors) | | | 0.0097*** (0.0022) | |
| (Government expenditure)*(institutional factors) | | | | 0.0126 (0.0109) |
| Middle East/North Africa dummy | 0.0090** (0.0041) | 0.0123*** (0.0042) | 0.0119*** (0.0042) | 0.0113*** (0.0043) |
| Sub-Saharan Africa dummy | -0.0636*** (0.0042) | -0.0628*** (0.0045) | -0.0608*** (0.0042) | -0.0638*** (0.0043) |
| Constant | 0.1813*** (0.0082) | 0.1813*** (0.0081) | 0.2005*** (0.0093) | 0.1867*** (0.0098) |
| Variance equation | | | | |
| Per capita GDP growth rate (ggdp) | -11.7917*** (1.4828) | -11.7450*** (1.3321) | -12.3234*** (1.4588) | -11.7651*** (1.4345) |
| Square of per capita GDP growth rate (ggdp ²) | 58.6792*** (8.6801) | 30.7052*** (10.7640) | 57.8190*** (8.7162) | 36.5273*** (9.9001) |
| Institutional factors (institution) | -0.2414*** (0.0376) | -0.1598*** (0.0451) | -0.1026 (0.0993) | -0.2078* (0.1072) |
| Inflation rate (inflation) | -0.0051 (0.0571) | -0.0008 (0.0420) | -0.0041 (0.0547) | -0.0030 (0.0466) |
| Trade openness (trade) | 1.5789*** (0.1740) | 1.5880*** (0.1867) | 2.4629*** (0.6915) | 1.5633*** (0.1744) |
| Government expenditure (gov_size) | -4.6019*** (1.1606) | -1.4393 (1.3784) | -4.9225*** (1.2481) | -3.6446 (2.9059) |
| (Per capita GDP)*(institutional factors) | | -0.0068*** (0.0014) | | |
| (Trade openness)*(institutional factors) | | | -0.2123 (0.1461) | |
| (Government expenditure)*(institutional factors) | | | | -0.2879 (0.6404) |
| Middle East/North Africa dummy | 0.6274*** (0.2139) | 0.2058 (0.2544) | 0.6529*** (0.2273) | 0.6074*** (0.2135) |
| Sub-Saharan Africa dummy | 0.8938*** (0.2293) | 0.7440*** (0.2299) | 0.9080*** (0.2306) | 0.8602*** (0.2330) |
| Constant | -7.2036*** (0.2791) | -7.5616*** (0.2943) | -7.7041*** (0.4636) | -7.2461*** (0.4706) |
| σ_{t-1}^2 | 0.9282*** (0.0696) | 0.9362*** (0.0719) | 0.9392*** (0.0701) | 0.9213*** (0.0701) |
| σ_{t-2}^2 | 0.0514** (0.0253) | 0.0530** (0.0247) | 0.0359 (0.0231) | 0.0591** (0.0265) |
| Log likelihood | 2562.613 | 2567.464 | 2570.428 | 2560.961 |
| Turning point of growth | 10.05% | 19.13% | 10.66% | 16.10% |
| Number of observations | 1575.0000 | 1575.0000 | 1575.0000 | 1575.0000 |

Notes:

1. The numbers in parentheses are standard errors.

2. The asterisks ***, **, and * are 1%, 5%, and 10% of significance levels, respectively.

Table C1 (continued): GS and its volatility (ARCH-M estimation)

Dependent variable: log(GS)

| Sample period: 1984-2008 | External Conflict | External Conflict | External Conflict | External Conflict |
|---|-------------------------|-------------------------|-------------------------|-------------------------|
| Independent variables | (5) | (6) | (7) | (8) |
| GS volatility (σ^2) | -0.9431*** (0.2570) | -0.8142*** (0.2617) | -1.0270*** (0.2640) | -0.9598*** (0.2476) |
| Per capita GDP growth rate (ggdp) | 0.2269*** (0.0217) | 0.2123*** (0.0215) | 0.2185*** (0.0215) | 0.2061*** (0.0220) |
| Age dependency (age_dep) | -0.0918*** (0.0078) | -0.0926*** (0.0090) | -0.0966*** (0.0079) | -0.0945*** (0.0077) |
| Urban population rate (urban) | -0.1227*** (0.0038) | -0.1024*** (0.0056) | -0.1269*** (0.0036) | -0.1293*** (0.0036) |
| Institutional factors (institution) | 0.0006 (0.0005) | 0.0014*** (0.0005) | 0.0034*** (0.0009) | 0.0031*** (0.0011) |
| Inflation rate (inflation) | -0.0001 (0.0003) | -0.0001 (0.0004) | -0.0001 (0.0003) | -0.0001 (0.0003) |
| Trade openness (trade) | 0.0393*** (0.0024) | 0.0400*** (0.0022) | 0.0970*** (0.0174) | 0.0410*** (0.0025) |
| Government expenditure (gov_size) | 0.1764*** (0.0188) | 0.1916*** (0.0217) | 0.1818*** (0.0190) | 0.3673*** (0.0709) |
| (Per capita GDP)*(institutional factors) | | -0.0000*** (0.0000) | | |
| (Trade openness)*(institutional factors) | | | -0.0054*** (0.0015) | |
| (Government expenditure)*(institutional factors) | | | | -0.0173*** (0.0065) |
| Middle East/North Africa dummy | 0.0126*** (0.0042) | 0.0084* (0.0044) | 0.0082* (0.0043) | 0.0031 (0.0044) |
| Sub-Saharan Africa dummy | -0.0589*** (0.0042) | -0.0633*** (0.0044) | -0.0579*** (0.0042) | -0.0584*** (0.0040) |
| Constant | 0.1770*** (0.0089) | 0.1616*** (0.0090) | 0.1537*** (0.0122) | 0.1551*** (0.0137) |
| Variance equation | | | | |
| Per capita GDP growth rate (ggdp) | -10.8880*** (1.4540) | -9.1030*** (1.3876) | -11.0682*** (1.5410) | -12.5388*** (1.6525) |
| Square of per capita GDP growth rate (ggdp ²) | 64.3870*** (8.8507) | 35.5478*** (10.0139) | 63.5839*** (8.9765) | 63.2333*** (6.6542) |
| Institutional factors (institution) | -0.1446*** (0.0390) | -0.0603 (0.0386) | -0.1389* (0.0842) | -0.2933** (0.1275) |
| Inflation rate (inflation) | 0.0007 (0.0393) | 0.0044 (0.0282) | 0.0007 (0.0392) | 0.0001 (0.0451) |
| Trade openness (trade) | 1.5669*** (0.1903) | 1.2707*** (0.1857) | 1.7863 (1.2011) | 1.6339*** (0.1909) |
| Government expenditure (gov_size) | -5.1148*** (1.2987) | 2.4053 (1.4972) | -6.1220*** (1.3806) | -17.2293** (7.6643) |
| (Per capita GDP)*(institutional factors) | | -0.0058*** (0.0007) | | |
| (Trade openness)*(institutional factors) | | | -0.0244 (0.1195) | |
| (Government expenditure)*(institutional factors) | | | | 1.1096 (0.7342) |
| Middle East/North Africa dummy | 0.5699*** (0.2212) | -0.1872 (0.2595) | 0.6391*** (0.2272) | 0.7361*** (0.2307) |
| Sub-Saharan Africa dummy | 1.1151*** (0.2158) | 0.7556*** (0.2205) | 1.0957*** (0.2172) | 1.0031*** (0.2301) |
| Constant | -6.7380*** (0.3733) | -7.6759*** (0.3786) | -6.6484*** (0.8119) | -5.1910*** (1.2564) |
| σ_{t-1}^2 | 0.9321*** (0.0689) | 0.9702*** (0.0741) | 0.9219*** (0.0695) | 0.9288*** (0.0687) |
| σ_{t-2}^2 | 0.0694*** (0.0259) | 0.0535** (0.0239) | 0.0845*** (0.0271) | 0.0855*** (0.0267) |
| Log likelihood | 2556.996 | 2567.351 | 2560.744 | 2557.812 |
| Turning point of growth | 8.46% | 12.80% | 8.70% | 9.91% |
| Number of observations | 1575.0000 | 1575.0000 | 1575.0000 | 1575.0000 |

Notes:

1. The numbers in parentheses are standard errors.

2. The asterisks ***, **, and * are 1%, 5%, and 10% of significance levels, respectively.

Table C1 (continued): GS and its volatility (ARCH-M estimation)

Dependent variable: log(GS)

| Sample period: 1984-2008 | Government Stability (9) | Government Stability (10) | Government Stability (11) | Government Stability (12) |
|---|--------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Independent variables | | | | |
| GS volatility (σ^2) | -0.9377*** (0.2608) | -0.8712*** (0.2585) | -0.9430*** (0.2562) | -0.9395*** (0.2678) |
| Per capita GDP growth rate (ggdp) | 0.2176*** (0.0214) | 0.2135*** (0.0220) | 0.2200*** (0.0223) | 0.2013*** (0.0212) |
| Age dependency (age_dep) | -0.0700*** (0.0072) | -0.0824*** (0.0084) | -0.0731*** (0.0073) | -0.0700*** (0.0074) |
| Urban population rate (urban) | -0.1267*** (0.0040) | -0.1083*** (0.0055) | -0.1283*** (0.0038) | -0.1285*** (0.0041) |
| Institutional factors (institution) | 0.0022*** (0.0004) | 0.0027*** (0.0004) | 0.0032*** (0.0009) | 0.0042*** (0.0010) |
| Inflation rate (inflation) | -0.0001 (0.0003) | -0.0001 (0.0003) | -0.0002 (0.0003) | 0.0001 (0.0006) |
| Trade openness (trade) | 0.0425*** (0.0023) | 0.0406*** (0.0018) | 0.0565*** (0.0107) | 0.0418*** (0.0023) |
| Government expenditure (gov_size) | 0.1919*** (0.0181) | 0.2082*** (0.0173) | 0.1960*** (0.0181) | 0.2913*** (0.0537) |
| (Per capita GDP)*(institutional factors) | | -0.0001*** (0.0000) | | |
| (Trade openness)*(institutional factors) | | | -0.0021 (0.0014) | |
| (Government expenditure)*(institutional factors) | | | | -0.0135** (0.0068) |
| Middle East/North Africa dummy | 0.0036 (0.0039) | 0.0026 (0.0039) | 0.0034 (0.0039) | -0.0017 (0.0043) |
| Sub-Saharan Africa dummy | -0.0700*** (0.0043) | -0.0688*** (0.0041) | -0.0698*** (0.0044) | -0.0709*** (0.0042) |
| Constant | 0.1528*** (0.0078) | 0.1502*** (0.0083) | 0.1483*** (0.0097) | 0.1406*** (0.0104) |
| Variance equation | | | | |
| Per capita GDP growth rate (ggdp) | -11.2302*** (1.5265) | -9.5176*** (1.5018) | -11.7508*** (1.6340) | -11.3927*** (1.4317) |
| Square of per capita GDP growth rate (ggdp ²) | 59.2339*** (8.9930) | 55.8593*** (9.2978) | 59.2096*** (6.9881) | 52.7693*** (9.2096) |
| Institutional factors (institution) | -0.0704** (0.0332) | 0.0158 (0.0376) | -0.1958*** (0.0640) | 0.1066 (0.0763) |
| Inflation rate (inflation) | -0.0038 (0.0420) | 0.0009 (0.0348) | -0.0077 (0.0548) | 0.0144** (0.0057) |
| Trade openness (trade) | 1.4704*** (0.2197) | 1.1905*** (0.2316) | -0.0309 (0.6740) | 1.4955*** (0.2264) |
| Government expenditure (gov_size) | -6.4032*** (1.2151) | 0.7262 (1.4451) | -6.2764*** (1.2669) | 3.8302 (3.5085) |
| (Per capita GDP)*(institutional factors) | | -0.0072*** (0.0009) | | |
| (Trade openness)*(institutional factors) | | | 0.1936** (0.0790) | |
| (Government expenditure)*(institutional factors) | | | | -1.3601*** (0.4831) |
| Middle East/North Africa dummy | 0.9221*** (0.2184) | 0.1468 (0.2675) | 0.8338*** (0.2499) | 1.0556*** (0.2331) |
| Sub-Saharan Africa dummy | 1.2319*** (0.2457) | 0.8307*** (0.2493) | 1.2456*** (0.2437) | 1.1841*** (0.2460) |
| Constant | -7.4442*** (0.2973) | -8.2461*** (0.3040) | -6.5290*** (0.5002) | -8.7662*** (0.5331) |
| σ_{t-1}^2 | 0.9395*** (0.0666) | 0.9762*** (0.0732) | 0.9454*** (0.0672) | 0.9221*** (0.0704) |
| σ_{t-2}^2 | 0.0749*** (0.0256) | 0.0672*** (0.0257) | 0.0781*** (0.0254) | 0.0796*** (0.0257) |
| Log likelihood | 2561.475 | 2575.601 | 2562.311 | 2562.845 |
| Turning point of growth | 9.48% | 8.52% | 9.92% | 10.79% |
| Number of observations | 1575.0000 | 1575.0000 | 1575.0000 | 1575.0000 |

Notes:

1. The numbers in parentheses are standard errors.

2. The asterisks ***, **, and * are 1%, 5%, and 10% of significance levels, respectively.

Table C1 (continued): GS and its volatility (ARCH-M estimation)

Dependent variable: log(GS)

| Sample period: 1984-2008 | Internal Conflict (13) | Internal Conflict (14) | Internal Conflict (15) | Internal Conflict (16) |
|---|------------------------------|------------------------------|------------------------------|------------------------------|
| Independent variables | | | | |
| GS volatility (σ^2) | -0.9363*** (0.2541) | -0.8236*** (0.2538) | -0.9604*** (0.2561) | -0.8976*** (0.2534) |
| Per capita GDP growth rate (ggdp) | 0.2083*** (0.0210) | 0.1965*** (0.0217) | 0.2063*** (0.0213) | 0.1868*** (0.0213) |
| Age dependency (age_dep) | -0.0848*** (0.0088) | -0.0939*** (0.0093) | -0.0825*** (0.0089) | -0.0880*** (0.0081) |
| Urban population rate (urban) | -0.1224*** (0.0046) | -0.1104*** (0.0055) | -0.1239*** (0.0046) | -0.1275*** (0.0046) |
| Institutional factors (institution) | 0.0009* (0.0005) | 0.0014*** (0.0005) | 0.0021** (0.0009) | 0.0031*** (0.0010) |
| Inflation rate (inflation) | 0.0002 (0.0006) | -0.0001 (0.0003) | -0.0001 (0.0003) | -0.0001 (0.0003) |
| Trade openness (trade) | 0.0429*** (0.0024) | 0.0416*** (0.0021) | 0.0652*** (0.0153) | 0.0440*** (0.0023) |
| Government expenditure (gov_size) | 0.1561*** (0.0187) | 0.1816*** (0.0199) | 0.1647*** (0.0189) | 0.2971*** (0.0636) |
| (Per capita GDP)*(institutional factors) | | -0.0000*** (0.0000) | | |
| (Trade openness)*(institutional factors) | | | -0.0023 (0.0015) | |
| (Government expenditure)*(institutional factors) | | | | -0.0143** (0.0064) |
| Middle East/North Africa dummy | 0.0093** (0.0041) | 0.0062 (0.0042) | 0.0075* (0.0042) | 0.0053 (0.0042) |
| Sub-Saharan Africa dummy | -0.0633*** (0.0043) | -0.0652*** (0.0044) | -0.0636*** (0.0043) | -0.0645*** (0.0042) |
| Constant | 0.1725*** (0.0097) | 0.1687*** (0.0095) | 0.1593*** (0.0129) | 0.1574*** (0.0108) |
| Variance equation | | | | |
| Per capita GDP growth rate (ggdp) | -10.7408*** (1.3344) | -10.4286*** (1.4722) | -11.0644*** (1.5315) | -12.5492*** (1.6725) |
| Square of per capita GDP growth rate (ggdp ²) | 59.9890*** (8.6018) | 53.2616*** (9.2489) | 63.9279*** (6.8295) | 53.7633*** (9.0891) |
| Institutional factors (institution) | -0.1196*** (0.0256) | -0.0289 (0.0329) | -0.1130* (0.0603) | -0.0361 (0.0747) |
| Inflation rate (inflation) | 0.0141** (0.0056) | 0.0007 (0.0393) | -0.0024 (0.0589) | -0.0021 (0.0536) |
| Trade openness (trade) | 1.5385*** (0.1718) | 1.2950*** (0.1929) | 1.5972* (0.9080) | 1.5381*** (0.1796) |
| Government expenditure (gov_size) | -3.3397*** (1.2213) | 1.4977 (1.4938) | -3.8086*** (1.2808) | 1.5316 (4.6891) |
| (Per capita GDP)*(institutional factors) | | -0.0045*** (0.0007) | | |
| (Trade openness)*(institutional factors) | | | -0.0034 (0.0923) | |
| (Government expenditure)*(institutional factors) | | | | -0.5326 (0.4806) |
| Middle East/North Africa dummy | 0.5179** (0.2084) | 0.0108 (0.2470) | 0.5351** (0.2112) | 0.5387** (0.2099) |
| Sub-Saharan Africa dummy | 1.0801*** (0.2237) | 0.8692*** (0.2220) | 1.0969*** (0.2261) | 1.0898*** (0.2293) |
| Constant | -7.3273*** (0.2631) | -8.0901*** (0.2999) | -7.3468*** (0.5738) | -8.0501*** (0.6662) |
| σ_{t-1}^2 | 0.9380*** (0.0684) | 0.9691*** (0.0723) | 0.9363*** (0.0692) | 0.9466*** (0.0709) |
| σ_{t-2}^2 | 0.0562** (0.0242) | 0.0469** (0.0228) | 0.0625** (0.0259) | 0.0593** (0.0243) |
| Log likelihood | 2556.832 | 2566.992 | 2557.602 | 2559.448 |
| Turning point of growth | 8.95% | 9.79% | 8.65% | 11.67% |
| Number of observations | 1575.0000 | 1575.0000 | 1575.0000 | 1575.0000 |

Notes:

1. The numbers in parentheses are standard errors.

2. The asterisks ***, **, and * are 1%, 5%, and 10% of significance levels, respectively.

Table C1 (continued): GS and its volatility (ARCH-M estimation)

Dependent variable: log(GS)

| Sample period: 1984-2008 | Investment Profile (17) | Investment Profile (18) | Investment Profile (19) | Investment Profile (20) |
|---|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| Independent variables | | | | |
| GS volatility (σ^2) | -0.8586*** (0.2767) | -0.8189*** (0.2547) | -0.9620*** (0.2801) | -0.8997*** (0.2691) |
| Per capita GDP growth rate (ggdp) | 0.2407*** (0.0234) | 0.2356*** (0.0240) | 0.2216*** (0.0248) | 0.2354*** (0.0248) |
| Age dependency (age_dep) | -0.0887*** (0.0076) | -0.0836*** (0.0083) | -0.0773*** (0.0076) | -0.0866*** (0.0079) |
| Urban population rate (urban) | -0.1246*** (0.0041) | -0.1219*** (0.0050) | -0.1276*** (0.0041) | -0.1235*** (0.0042) |
| Institutional factors (institution) | 0.0005 (0.0004) | 0.0003 (0.0005) | 0.0043*** (0.0007) | 0.0016 (0.0011) |
| Inflation rate (inflation) | -0.0001 (0.0004) | -0.0001 (0.0003) | -0.0002 (0.0003) | -0.0002 (0.0003) |
| Trade openness (trade) | 0.0363*** (0.0024) | 0.0344*** (0.0022) | 0.0856*** (0.0093) | 0.0375*** (0.0027) |
| Government expenditure (gov_size) | 0.1940*** (0.0191) | 0.1618*** (0.0194) | 0.1927*** (0.0188) | 0.2286*** (0.0506) |
| (Per capita GDP)*(institutional factors) | | 0.0000** (0.0000) | | |
| (Trade openness)*(institutional factors) | | | -0.0053*** (0.0009) | |
| (Government expenditure)*(institutional factors) | | | | -0.0056 (0.0060) |
| Middle East/North Africa dummy | 0.0074* (0.0040) | 0.0091** (0.0040) | 0.0007 (0.0039) | 0.0066 (0.0042) |
| Sub-Saharan Africa dummy | -0.0616*** (0.0044) | -0.0631*** (0.0047) | -0.0681*** (0.0045) | -0.0634*** (0.0044) |
| Constant | 0.1770*** (0.0075) | 0.1780*** (0.0086) | 0.1410*** (0.0098) | 0.1679*** (0.0124) |
| Variance equation | | | | |
| Per capita GDP growth rate (ggdp) | -10.4843*** (1.4818) | -10.4402*** (1.5717) | -10.0914*** (1.7541) | -10.1775*** (1.5386) |
| Square of per capita GDP growth rate (ggdp ²) | 38.9785*** (10.8552) | 59.2596*** (9.2748) | 60.1553*** (9.6562) | 62.1548*** (9.1540) |
| Institutional factors (institution) | -0.1061*** (0.0298) | -0.0276 (0.0466) | -0.2245*** (0.0615) | -0.1284 (0.0908) |
| Inflation rate (inflation) | -0.0027 (0.0355) | -0.0010 (0.0406) | -0.0095 (0.0506) | -0.0054 (0.0436) |
| Trade openness (trade) | 1.5389*** (0.1913) | 1.4973*** (0.1973) | 0.5955 (0.6300) | 1.5092*** (0.1921) |
| Government expenditure (gov_size) | -5.8550*** (1.3247) | -2.8804** (1.4245) | -5.8885*** (1.3811) | -6.5712 (4.1201) |
| (Per capita GDP)*(institutional factors) | | -0.0029*** (0.0009) | | |
| (Trade openness)*(institutional factors) | | | 0.1281 (0.0781) | |
| (Government expenditure)*(institutional factors) | | | | 0.1543 (0.5208) |
| Middle East/North Africa dummy | 0.7831*** (0.2271) | 0.4431* (0.2552) | 0.6510** (0.2565) | 0.7421*** (0.2350) |
| Sub-Saharan Africa dummy | 1.1898*** (0.2004) | 1.1441*** (0.1965) | 1.2747*** (0.2052) | 1.2448*** (0.2009) |
| Constant | -7.2244*** (0.2820) | -7.9282*** (0.3600) | -6.4692*** (0.4954) | -7.1427*** (0.6684) |
| σ_{t-1}^2 | 0.9350*** (0.0706) | 0.9678*** (0.0731) | 0.9221*** (0.0725) | 0.9316*** (0.0723) |
| σ_{t-2}^2 | 0.0650** (0.0277) | 0.0402 (0.0248) | 0.0727*** (0.0281) | 0.0573** (0.0273) |
| Log likelihood | 2552.848 | 2557.896 | 2563.057 | 2555.227 |
| Turning point of growth | 13.45% | 8.81% | 8.39% | 8.19% |
| Number of observations | 1575.0000 | 1575.0000 | 1575.0000 | 1575.0000 |

Notes:

1. The numbers in parentheses are standard errors.

2. The asterisks ***, **, and * are 1%, 5%, and 10% of significance levels, respectively.

Table C1 (continued): GS and its volatility (ARCH-M estimation)

Dependent variable: log(GS)

| Sample period: 1984-2008 | Military in Politics (21) | Military in Politics (22) | Military in Politics (23) | Military in Politics (24) |
|---|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Independent variables | | | | |
| GS volatility (σ^2) | -0.8291*** (0.2548) | -0.8252*** (0.2553) | -1.0064*** (0.2720) | -0.8170*** (0.2696) |
| Per capita GDP growth rate (ggdp) | 0.2389*** (0.0225) | 0.2318*** (0.0236) | 0.2281*** (0.0222) | 0.2309*** (0.0226) |
| Age dependency (age_dep) | -0.0989*** (0.0092) | -0.0994*** (0.0095) | -0.0843*** (0.0091) | -0.0997*** (0.0092) |
| Urban population rate (urban) | -0.1145*** (0.0047) | -0.1101*** (0.0054) | -0.1188*** (0.0047) | -0.1137*** (0.0048) |
| Institutional factors (institution) | -0.0007 (0.0007) | -0.0004 (0.0008) | 0.0042*** (0.0013) | 0.0010 (0.0014) |
| Inflation rate (inflation) | -0.0002 (0.0003) | -0.0001 (0.0003) | -0.0002 (0.0002) | -0.0001 (0.0003) |
| Trade openness (trade) | 0.0404*** (0.0024) | 0.0408*** (0.0023) | 0.0882*** (0.0098) | 0.0401*** (0.0024) |
| Government expenditure (gov_size) | 0.1710*** (0.0204) | 0.1872*** (0.0224) | 0.1980*** (0.0207) | 0.2460*** (0.0558) |
| (Per capita GDP)*(institutional factors) | | -0.0000* (0.0000) | | |
| (Trade openness)*(institutional factors) | | | -0.0090*** (0.0019) | |
| (Government expenditure)*(institutional factors) | | | | -0.0149 (0.0106) |
| Middle East/North Africa dummy | 0.0083* (0.0044) | 0.0066 (0.0045) | 0.0006 (0.0043) | 0.0041 (0.0047) |
| Sub-Saharan Africa dummy | -0.0622*** (0.0043) | -0.0630*** (0.0045) | -0.0671*** (0.0043) | -0.0623*** (0.0044) |
| Constant | 0.1850*** (0.0086) | 0.1816*** (0.0087) | 0.1513*** (0.0104) | 0.1775*** (0.0105) |
| Variance equation | | | | |
| Per capita GDP growth rate (ggdp) | -9.5885*** (1.4621) | -9.3772*** (1.4868) | -10.3576*** (1.7254) | -9.8117*** (1.4297) |
| Square of per capita GDP growth rate (ggdp ²) | 63.3116*** (8.8178) | 59.7017*** (9.0209) | 59.5275*** (9.5182) | 39.2062*** (9.6067) |
| Institutional factors (institution) | -0.3068*** (0.0439) | -0.2278*** (0.0614) | -0.4608*** (0.1061) | -0.1434 (0.1182) |
| Inflation rate (inflation) | -0.0040 (0.0457) | -0.0020 (0.0431) | -0.0078 (0.0572) | -0.0003 (0.0359) |
| Trade openness (trade) | 1.5574*** (0.1819) | 1.4484*** (0.1994) | 0.3957 (0.6473) | 1.5150*** (0.1961) |
| Government expenditure (gov_size) | -0.3141 (1.3721) | 1.5381 (1.5650) | -1.3770 (1.4993) | 4.5369 (3.3112) |
| (Per capita GDP)*(institutional factors) | | -0.0040*** (0.0015) | | |
| (Trade openness)*(institutional factors) | | | 0.2774** (0.1321) | |
| (Government expenditure)*(institutional factors) | | | | -1.1984* (0.7128) |
| Middle East/North Africa dummy | 0.3343 (0.2264) | 0.0980 (0.2552) | 0.3301 (0.2393) | 0.2914 (0.2360) |
| Sub-Saharan Africa dummy | 0.8905*** (0.2263) | 0.8196*** (0.2253) | 0.9060*** (0.2367) | 0.8702*** (0.2384) |
| Constant | -7.6290*** (0.2430) | -7.8658*** (0.2682) | -6.8880*** (0.4766) | -8.1545*** (0.4506) |
| σ_{t-1}^2 | 0.9346*** (0.0709) | 0.9410*** (0.0718) | 0.9084*** (0.0710) | 0.9306*** (0.0713) |
| σ_{t-2}^2 | 0.0493** (0.0231) | 0.0480** (0.0228) | 0.0823*** (0.0283) | 0.0592** (0.0251) |
| Log likelihood | 2567.173 | 2568.901 | 2575.224 | 2566.155 |
| Turning point of growth | 7.57% | 7.85% | 8.70% | 12.51% |
| Number of observations | 1575.0000 | 1575.0000 | 1575.0000 | 1575.0000 |

Notes:

1. The numbers in parentheses are standard errors.

2. The asterisks ***, **, and * are 1%, 5%, and 10% of significance levels, respectively.

Table C1 (continued): GS and its volatility (ARCH-M estimation)

Dependent variable: log(GS)

| Sample period: 1984-2008 | Religion Tension (25) | Religion Tension (26) | Religion Tension (27) | Religion Tension (28) |
|---|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Independent variables | | | | |
| GS volatility (σ^2) | -0.8746*** (0.2591) | -0.8495*** (0.2763) | -0.9287*** (0.2651) | -0.9157*** (0.2643) |
| Per capita GDP growth rate (ggdp) | 0.2354*** (0.0202) | 0.2259*** (0.0220) | 0.2326*** (0.0213) | 0.2519*** (0.0208) |
| Age dependency (age_dep) | -0.0808*** (0.0078) | -0.0762*** (0.0088) | -0.0855*** (0.0079) | -0.0794*** (0.0078) |
| Urban population rate (urban) | -0.1142*** (0.0043) | -0.1240*** (0.0051) | -0.1153*** (0.0048) | -0.1035*** (0.0043) |
| Institutional factors (institution) | 0.0007 (0.0007) | 0.0004 (0.0008) | 0.0007 (0.0014) | -0.0074*** (0.0018) |
| Inflation rate (inflation) | -0.0001 (0.0003) | -0.0001 (0.0004) | -0.0001 (0.0003) | -0.0001 (0.0003) |
| Trade openness (trade) | 0.0420*** (0.0027) | 0.0398*** (0.0024) | 0.0537*** (0.0121) | 0.0429*** (0.0028) |
| Government expenditure (gov_size) | 0.1781*** (0.0188) | 0.1370*** (0.0193) | 0.1829*** (0.0187) | -0.0858 (0.0558) |
| (Per capita GDP)*(institutional factors) | | 0.0001*** (0.0000) | | |
| (Trade openness)*(institutional factors) | | | -0.0019 (0.0024) | |
| (Government expenditure)*(institutional factors) | | | | 0.0510*** (0.0107) |
| Middle East/North Africa dummy | 0.0090** (0.0042) | 0.0123*** (0.0043) | 0.0065 (0.0043) | 0.0172*** (0.0044) |
| Sub-Saharan Africa dummy | -0.0654*** (0.0042) | -0.0626*** (0.0047) | -0.0611*** (0.0042) | -0.0622*** (0.0045) |
| Constant | 0.1663*** (0.0081) | 0.1725*** (0.0083) | 0.1679*** (0.0099) | 0.1982*** (0.0102) |
| Variance equation | | | | |
| Per capita GDP growth rate (ggdp) | -11.7382*** (1.3989) | -11.7192*** (1.3152) | -12.2120*** (1.4719) | -11.6339*** (1.4553) |
| Square of per capita GDP growth rate (ggdp ²) | 63.6473*** (8.7380) | 30.9533*** (10.2580) | 59.3463*** (9.0117) | 64.4020*** (8.7641) |
| Institutional factors (institution) | -0.2293*** (0.0391) | -0.0922* (0.0516) | 0.0456 (0.0991) | 0.0730 (0.1201) |
| Inflation rate (inflation) | -0.0019 (0.0388) | 0.0015 (0.0336) | -0.0018 (0.0389) | -0.0017 (0.0445) |
| Trade openness (trade) | 1.4744*** (0.1767) | 1.4505*** (0.1726) | 3.7280*** (0.5981) | 1.1966*** (0.1758) |
| Government expenditure (gov_size) | -4.9521*** (1.1950) | -1.2332 (1.4348) | -5.7349*** (1.2639) | 3.5851 (3.4600) |
| (Per capita GDP)*(institutional factors) | | -0.0086*** (0.0015) | | |
| (Trade openness)*(institutional factors) | | | -0.4959*** (0.1298) | |
| (Government expenditure)*(institutional factors) | | | | -1.9548*** (0.7110) |
| Middle East/North Africa dummy | 0.3339 (0.2156) | 0.0085 (0.2600) | 0.1654 (0.2110) | 0.2040 (0.2598) |
| Sub-Saharan Africa dummy | 1.2353*** (0.2042) | 0.8830*** (0.2031) | 1.2428*** (0.2063) | 1.2117*** (0.2038) |
| Constant | -7.0620*** (0.2918) | -7.5974*** (0.3374) | -8.1476*** (0.4709) | -8.1835*** (0.5678) |
| σ_{t-1}^2 | 0.9322*** (0.0686) | 0.9346*** (0.0729) | 0.9154*** (0.0691) | 0.9216*** (0.0725) |
| σ_{t-2}^2 | 0.0655** (0.0272) | 0.0632** (0.0268) | 0.0774*** (0.0275) | 0.0772*** (0.0295) |
| Log likelihood | 2559.244 | 2569.631 | 2562.881 | 2569.333 |
| Turning point of growth | 9.22% | 18.93% | 10.29% | 9.03% |
| Number of observations | 1575.0000 | 1575.0000 | 1575.0000 | 1575.0000 |

Notes:

1. The numbers in parentheses are standard errors.

2. The asterisks ***, **, and * are 1%, 5%, and 10% of significance levels, respectively.

Table C1 (continued): GS and its volatility (ARCH-M estimation)

Dependent variable: log(GS)

| Sample period: 1984-2008 | Socio-economic Condition (29) | Socio-economic Condition (30) | Socio-economic Condition (31) | Socio-economic Condition (32) |
|---|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| Independent variables | | | | |
| GS volatility (σ^2) | -0.8020*** (0.2762) | -0.8135*** (0.2626) | -1.0271*** (0.2928) | -0.8665*** (0.2886) |
| Per capita GDP growth rate (ggdp) | 0.2401*** (0.0212) | 0.2236*** (0.0240) | 0.2415*** (0.0254) | 0.2275*** (0.0220) |
| Age dependency (age_dep) | -0.0760*** (0.0074) | -0.0820*** (0.0078) | -0.0664*** (0.0078) | -0.0740*** (0.0076) |
| Urban population rate (urban) | -0.1195*** (0.0041) | -0.1110*** (0.0047) | -0.1146*** (0.0046) | -0.1202*** (0.0043) |
| Institutional factors (institution) | 0.0023*** (0.0004) | 0.0032*** (0.0007) | 0.0071*** (0.0008) | 0.0063*** (0.0012) |
| Inflation rate (inflation) | -0.0002 (0.0003) | -0.0002 (0.0003) | -0.0003 (0.0003) | -0.0002 (0.0003) |
| Trade openness (trade) | 0.0382*** (0.0020) | 0.0396*** (0.0022) | 0.0980*** (0.0090) | 0.0418*** (0.0022) |
| Government expenditure (gov_size) | 0.1587*** (0.0181) | 0.1817*** (0.0195) | 0.1716*** (0.0192) | 0.3200*** (0.0532) |
| (Per capita GDP)*(institutional factors) | | -0.0000*** (0.0000) | | |
| (Trade openness)*(institutional factors) | | | -0.0075*** (0.0011) | |
| (Government expenditure)*(institutional factors) | | | | -0.0239*** (0.0071) |
| Middle East/North Africa dummy | 0.0099*** (0.0038) | 0.0069* (0.0039) | 0.0062 (0.0038) | 0.0070* (0.0040) |
| Sub-Saharan Africa dummy | -0.0622*** (0.0044) | -0.0632*** (0.0046) | -0.0650*** (0.0045) | -0.0605*** (0.0044) |
| Constant | 0.1578*** (0.0074) | 0.1516*** (0.0078) | 0.1108*** (0.0098) | 0.1298*** (0.0116) |
| Variance equation | | | | |
| Per capita GDP growth rate (ggdp) | -10.8599*** (1.4884) | -10.3409*** (1.5771) | -9.6806*** (1.6497) | -11.6046*** (1.5303) |
| Square of per capita GDP growth rate (ggdp ²) | 31.4846** (13.8695) | 55.3362*** (9.2110) | 54.6326*** (10.9304) | 26.6928* (14.7412) |
| Institutional factors (institution) | -0.2618*** (0.0366) | -0.2285*** (0.0561) | -0.3201*** (0.0767) | -0.1964** (0.0992) |
| Inflation rate (inflation) | -0.0052 (0.0421) | -0.0075 (0.0487) | -0.0118 (0.0521) | -0.0048 (0.0405) |
| Trade openness (trade) | 1.4183*** (0.1816) | 1.2652*** (0.1769) | 0.7218 (0.5872) | 1.3843*** (0.1755) |
| Government expenditure (gov_size) | -2.0999 (1.5820) | -1.3560 (1.7316) | -2.3985 (1.6327) | 0.7503 (3.8335) |
| (Per capita GDP)*(institutional factors) | | -0.0011 (0.0011) | | |
| (Trade openness)*(institutional factors) | | | 0.0541 (0.1062) | |
| (Government expenditure)*(institutional factors) | | | | -0.4579 (0.6042) |
| Middle East/North Africa dummy | 0.4265 (0.2596) | 0.3695 (0.2731) | 0.4544* (0.2697) | 0.4012 (0.2626) |
| Sub-Saharan Africa dummy | 1.0783*** (0.1630) | 1.0707*** (0.1729) | 1.1198*** (0.1625) | 1.0629*** (0.1622) |
| Constant | -6.8847*** (0.2733) | -7.0250*** (0.3549) | -6.4064*** (0.4613) | -7.2293*** (0.5590) |
| σ_{t-1}^2 | 0.9236*** (0.0695) | 0.9334*** (0.0691) | 0.8848*** (0.0690) | 0.9028*** (0.0700) |
| σ_{t-2}^2 | 0.0600** (0.0255) | 0.0501** (0.0243) | 0.1045*** (0.0308) | 0.0753*** (0.0268) |
| Log likelihood | 2574.922 | 2577.018 | 2585.425 | 2578.405 |
| Turning point of growth | 17.25% | 9.34% | 8.86% | 21.74% |
| Number of observations | 1575.0000 | 1575.0000 | 1575.0000 | 1575.0000 |

Notes:

1. The numbers in parentheses are standard errors.

2. The asterisks ***, **, and * are 1%, 5%, and 10% of significance levels, respectively.

References

- Arrow, K. J., P. Dasgupta, and K-G. Mäler, 2003, Evaluating projects and assessing sustainable development in imperfect economies. *Environmental and Resource Economics*, **26**, pp.647-685.
- Arrow, K. J., P. Dasgupta, L. Goulder, G. Daily, P. Ehrlich, G. Heal, S. Levin, K.-G. Mäler, S. Schneider, D. Starrett and B. Walker, 2004, Are we consuming too much? *Journal of Economic Perspectives*, **18**, pp. 147-172.
- Bernanke, B., 1983, Irreversibility, uncertainty and cyclical investment. *Quarterly Journal of Economics*, **98**, pp. 85-106.
- Busse, M. and C. Hefeker, 2007, Political risk, institution and foreign direct investment. *European Journal of Political Economy*, **23**, pp. 397-415.
- Dasgupta, P., 2004, *Human Well-Being and the Natural Environment*. Oxford University Press, New York.
- Dietz, S., E. Neumayer and I. de Soysa, 2007, Corruption, the resource curse and genuine saving. *Environment and Development Economics*, **12**, pp. 33-53.
- Engle, R., 1982, Autoregressive conditional heteroskedasticity with estimates of the variance of United Kingdom inflation. *Econometrica*, **50**, pp. 987-1007.
- Engle, R., D. Lilien and R. Robins, 1987, Estimating time varying risk premia in the term structure: the ARCH-M model. *Econometrica*, **55**, pp. 391-407.
- Hamilton, K. and G. Atkinson, 2006, *Wealth, Welfare and Sustainability*. Edward Elgar, Cheltenham.
- Hamilton, K. and Clemens, M., 1999, Genuine savings rates in developing countries. *World Bank Economic Review*, **13**, pp. 333-356.
- International Country Risk Guide, 2009, Political Risk Service.

- Lee, J., 2010, The link between output growth and volatility: evidence from a GARCH model with panel data. *Economics Letters*, **106**, pp. 143-145.
- Mirman, L. J., 1971, Uncertainty and optimal consumption decisions. *Econometrica*, **39**, pp. 179-185.
- Pearce, D. W. and G. D. Atkinson, 1993, Capital theory and the measurement of sustainable development: an indicator of “weak” sustainability. *Ecological Economics*, **8**, pp. 103-108.
- Ramey, G. and V. A. Ramey, 1995, Cross-country evidence on the link between volatility and growth. *American Economic Review*, **85**, pp. 1138-1151.
- Sato, M., S. Samreth and K. Yamada, 2012, A numerical study on assessing sustainable development with future genuine savings simulation. *International Journal of Sustainable Development*, vol. 15, No. 4, pp.293-312.
- van der Ploeg, F. and S. Poelhekke, 2009, Volatility and the natural resource curse. *Oxford Economic Papers*, **61**, pp. 727-760.
- van der Ploeg, F., 2011, Rapacious resource depletion, excessive investment and insecure property rights: a puzzle. *Environmental and Resource Economics*, **48**, pp. 105-128.
- World Commission, 1987, *Our Common Future* (Brundtland Report). Oxford University Press, New York.
- World Development Indicators, 2010, the World Bank.
- Yang, B., 2008, Does democracy lower growth volatility? A dynamic panel analysis. *Journal of Macroeconomics*, **30**, pp. 562-574.

Table 1: Correlation of institution variables

| | Bureaucracy Quality | Corruption | Democratic Accountability | Ethnic Tension | External Conflict | Government Stability | Internal Conflict | Investment Profile | Law and Order | Military in Politics | Religious Tension | Socio-economic Condition |
|---------------------------|------------------------|------------|------------------------------|-------------------|----------------------|-------------------------|----------------------|-----------------------|------------------|-------------------------|----------------------|-----------------------------|
| Bureaucracy Quality | 1.0000 | | | | | | | | | | | |
| Corruption | 0.7194 | 1.0000 | | | | | | | | | | |
| Democratic Accountability | 0.6724 | 0.6168 | 1.0000 | | | | | | | | | |
| Ethnic Tension | 0.3369 | 0.4134 | 0.3320 | 1.0000 | | | | | | | | |
| External Conflict | 0.3565 | 0.3504 | 0.4315 | 0.4444 | 1.0000 | | | | | | | |
| Government Stability | 0.2579 | 0.1453 | 0.1694 | 0.2826 | 0.2900 | 1.0000 | | | | | | |
| Internal Conflict | 0.5322 | 0.5120 | 0.4994 | 0.6942 | 0.6172 | 0.4101 | 1.0000 | | | | | |
| Investment Profile | 0.4531 | 0.2428 | 0.4511 | 0.2821 | 0.3236 | 0.5744 | 0.4184 | 1.0000 | | | | |
| Law and Order | 0.7217 | 0.7054 | 0.5297 | 0.5606 | 0.4739 | 0.3662 | 0.7298 | 0.4328 | 1.0000 | | | |
| Military in Politics | 0.7145 | 0.6761 | 0.6938 | 0.4980 | 0.4630 | 0.2116 | 0.6581 | 0.4713 | 0.6834 | 1.0000 | | |
| Religious Tension | 0.2932 | 0.4178 | 0.3936 | 0.4743 | 0.4234 | 0.1159 | 0.5344 | 0.2590 | 0.3788 | 0.4743 | 1.0000 | |
| Socio-economic Condition | 0.6238 | 0.5256 | 0.4284 | 0.3747 | 0.2678 | 0.2419 | 0.4518 | 0.5579 | 0.6202 | 0.5329 | 0.3500 | 1.0000 |

Table 2: GS and its volatility (ARCH-M estimation)

Dependent variable: log(GS)

| Sample period: 1984-2008 | Bureaucratic Quality | Bureaucratic Quality | Bureaucratic Quality | Bureaucratic Quality |
|---|-------------------------|-------------------------|-------------------------|-------------------------|
| Independent variables | (1) | (2) | (3) | (4) |
| GS volatility (σ^2) | -1.0095*** (0.2488) | -1.0845*** (0.2974) | -1.1930*** (0.2614) | -0.9938*** (0.2674) |
| Per capita GDP growth rate (ggdp) | 0.2002*** (0.0222) | 0.2227*** (0.0224) | 0.2010*** (0.0221) | 0.2086*** (0.0236) |
| Age dependency (age_dep) | -0.0341*** (0.0072) | -0.0433*** (0.0086) | -0.0192*** (0.0069) | -0.0337*** (0.0077) |
| Urban population rate (urban) | -0.1004*** (0.0041) | -0.0988*** (0.0042) | -0.0981*** (0.0039) | -0.1023*** (0.0042) |
| Institutional factors (institution) | 0.0148*** (0.0010) | 0.0215*** (0.0013) | 0.0245*** (0.0016) | 0.0206*** (0.0019) |
| Inflation rate (inflation) | 0.0000 (0.0003) | 0.0000 (0.0003) | 0.0002 (0.0004) | -0.0011*** (0.0002) |
| Trade openness (trade) | 0.0393*** (0.0017) | 0.0452*** (0.0020) | 0.0918*** (0.0065) | 0.0380*** (0.0018) |
| Government expenditure (gov_size) | -0.0180 (0.0182) | 0.0326* (0.0191) | -0.0089 (0.0175) | 0.1014** (0.0420) |
| (Per capita GDP)*(institutional factors) | | -0.0003*** (0.0000) | | |
| (Trade openness)*(institutional factors) | | | -0.0153*** (0.0019) | |
| (Government expenditure)*(institutional factors) | | | | -0.0366*** (0.0122) |
| Middle East/North Africa dummy | 0.0109*** (0.0033) | 0.0059 (0.0041) | 0.0084** (0.0036) | 0.0084** (0.0036) |
| Sub-Saharan Africa dummy | -0.0667*** (0.0042) | -0.0698*** (0.0043) | -0.0682*** (0.0041) | -0.0674*** (0.0043) |
| Constant | 0.1284*** (0.0066) | 0.1166*** (0.0072) | 0.0860*** (0.0080) | 0.1135*** (0.0088) |
| Variance equation | | | | |
| Per capita GDP growth rate (ggdp) | -12.1057*** (1.4123) | -11.5626*** (1.3006) | -12.3864*** (1.4368) | -11.7968*** (1.4569) |
| Square of per capita GDP growth rate (ggdp ²) | 57.0954*** (7.1384) | 26.4317** (10.7384) | 56.6545*** (6.9797) | 48.5452*** (10.4018) |
| Institutional factors (institution) | -0.2066** (0.0871) | -0.1239 (0.0968) | -0.1625 (0.1403) | -0.0007 (0.1530) |
| Inflation rate (inflation) | 0.0041 (0.0194) | 0.0046 (0.0196) | 0.0073 (0.0124) | 0.0056 (0.0294) |
| Trade openness (trade) | 1.0054*** (0.1838) | 0.8716*** (0.2209) | 0.9225* (0.5268) | 0.9413*** (0.1890) |
| Government expenditure (gov_size) | -6.2145*** (1.7834) | -3.2223* (1.8076) | -7.9145*** (1.8241) | -0.8537 (3.7964) |
| (Per capita GDP)*(institutional factors) | | -0.0060** (0.0024) | | |
| (Trade openness)*(institutional factors) | | | -0.0100 (0.1693) | |
| (Government expenditure)*(institutional factors) | | | | -1.8505* (1.0985) |
| Middle East/North Africa dummy | 0.9179*** (0.3003) | 0.6202** (0.3085) | 0.9430*** (0.3197) | 0.8233** (0.3274) |
| Sub-Saharan Africa dummy | 1.1018*** (0.1874) | 0.8886*** (0.1931) | 1.2354*** (0.1838) | 1.0485*** (0.1931) |
| Constant | -7.2207*** (0.2095) | -7.4136*** (0.2283) | -7.1488*** (0.3280) | -7.7104*** (0.3910) |
| σ_{t-1}^2 | 0.9441*** (0.0659) | 0.8960*** (0.0658) | 0.9360*** (0.0643) | 0.9391*** (0.0666) |
| σ_{t-2}^2 | 0.0811*** (0.0232) | 0.1168*** (0.0279) | 0.1169*** (0.0268) | 0.0880*** (0.0247) |
| Log likelihood | 2586.251 | 2602.608 | 2605.525 | 2586.448 |
| Turning point of growth | 10.60% | 21.87% | 10.93% | 12.15% |
| Number of observations | 1575.0000 | 1575.0000 | 1575.0000 | 1575.0000 |

Notes:

1. The numbers in parentheses are standard errors.

2. The asterisks ***, **, and * are 1%, 5%, and 10% of significance levels, respectively.

Table 2 (continued): GS and its volatility (ARCH-M estimation)

| Dependent variable: log(GS) | | | | |
|---|-------------------------|-------------------------|-------------------------|-------------------------|
| Sample period: 1984-2008 | Corruption | Corruption | Corruption | Corruption |
| Independent variables | (5) | (6) | (7) | (8) |
| GS volatility (σ^2) | -0.7947*** (0.2337) | -0.6757*** (0.2475) | -0.9245*** (0.2409) | -0.6829*** (0.2472) |
| Per capita GDP growth rate (ggdp) | 0.2329*** (0.0202) | 0.2158*** (0.0222) | 0.2209*** (0.0204) | 0.2366*** (0.0201) |
| Age dependency (age_dep) | -0.0856*** (0.0084) | -0.0853*** (0.0089) | -0.0795*** (0.0087) | -0.0879*** (0.0086) |
| Urban population rate (urban) | -0.1137*** (0.0039) | -0.1072*** (0.0050) | -0.1155*** (0.0041) | -0.1135*** (0.0040) |
| Institutional factors (institution) | 0.0033*** (0.0008) | 0.0048*** (0.0008) | 0.0060*** (0.0015) | 0.0012 (0.0016) |
| Inflation rate (inflation) | -0.0002 (0.0002) | -0.0001 (0.0003) | -0.0004** (0.0002) | -0.0001 (0.0003) |
| Trade openness (trade) | 0.0385*** (0.0021) | 0.0412*** (0.0020) | 0.0629*** (0.0088) | 0.0367*** (0.0022) |
| Government expenditure (gov_size) | 0.1219*** (0.0196) | 0.1362*** (0.0222) | 0.1395*** (0.0214) | 0.0357 (0.0432) |
| (Per capita GDP)*(institutional factors) | | -0.0001*** (0.0000) | | |
| (Trade openness)*(institutional factors) | | | -0.0053*** (0.0021) | |
| (Government expenditure)*(institutional factors) | | | | 0.0179** (0.0089) |
| Middle East/North Africa dummy | 0.0154*** (0.0040) | 0.0106** (0.0042) | 0.0110*** (0.0042) | 0.0189*** (0.0041) |
| Sub-Saharan Africa dummy | -0.0544*** (0.0043) | -0.0601*** (0.0045) | -0.0569*** (0.0043) | -0.0537*** (0.0043) |
| Constant | 0.1683*** (0.0074) | 0.1610*** (0.0078) | 0.1523*** (0.0100) | 0.1800*** (0.0099) |
| Variance equation | | | | |
| Per capita GDP growth rate (ggdp) | -10.7823*** (1.3674) | -9.8533*** (1.3396) | -11.1450*** (1.3508) | -10.6968*** (1.3434) |
| Square of per capita GDP growth rate (ggdp ²) | 61.8716*** (8.7983) | 35.2312*** (10.1920) | 64.3651*** (6.2948) | 42.1620*** (9.6638) |
| Institutional factors (institution) | -0.4073*** (0.0561) | -0.1897*** (0.0615) | -0.5808*** (0.1165) | -0.1811 (0.1189) |
| Inflation rate (inflation) | -0.0074 (0.0461) | 0.0012 (0.0306) | -0.0172 (0.0457) | -0.0007 (0.0378) |
| Trade openness (trade) | 1.3148*** (0.1821) | 1.2092*** (0.2004) | 0.4743 (0.5496) | 1.2837*** (0.1936) |
| Government expenditure (gov_size) | 0.2496 (1.4811) | 3.6264** (1.7557) | 0.0223 (1.4573) | 3.7953 (3.0133) |
| (Per capita GDP)*(institutional factors) | | -0.0100*** (0.0017) | | |
| (Trade openness)*(institutional factors) | | | 0.2717** (0.1385) | |
| (Government expenditure)*(institutional factors) | | | | -1.3468** (0.6627) |
| Middle East/North Africa dummy | 0.1863 (0.2556) | -0.2324 (0.2907) | 0.1793 (0.2474) | 0.1796 (0.2643) |
| Sub-Saharan Africa dummy | 0.8663*** (0.2347) | 0.6475*** (0.2354) | 0.8360*** (0.2387) | 0.8131*** (0.2413) |
| Constant | -7.3646*** (0.2431) | -7.9549*** (0.2564) | -6.7879*** (0.3985) | -7.8775*** (0.4067) |
| σ_{t-1}^2 | 0.9650*** (0.0678) | 0.9716*** (0.0691) | 0.9469*** (0.0687) | 0.9622*** (0.0692) |
| σ_{t-2}^2 | 0.0246 (0.0170) | 0.0361* (0.0199) | 0.0351 (0.0221) | 0.0368* (0.0221) |
| Log likelihood | 2569.994 | 2573.94 | 2572.468 | 2568.896 |
| Turning point of growth | 8.71% | 13.98% | 8.66% | 12.69% |
| Number of observations | 1575.0000 | 1575.0000 | 1575.0000 | 1575.0000 |

Notes:

1. The numbers in parentheses are standard errors.

2. The asterisks ***, **, and * are 1%, 5%, and 10% of significance levels, respectively.

Table 2 (continued): GS and its volatility (ARCH-M estimation)

Dependent variable: log(GS)

| Sample period: 1984-2008 | Democratic Accountability (9) | Democratic Accountability (10) | Democratic Accountability (11) | Democratic Accountability (12) |
|---|-------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|
| Independent variables | | | | |
| GS volatility (σ^2) | -0.7988*** (0.2354) | -0.8140*** (0.2419) | -0.8486*** (0.2384) | -0.6972*** (0.2441) |
| Per capita GDP growth rate (ggdp) | 0.1582*** (0.0212) | 0.1864*** (0.0221) | 0.1593*** (0.0215) | 0.1595*** (0.0202) |
| Age dependency (age_dep) | -0.0540*** (0.0072) | -0.0703*** (0.0087) | -0.0475*** (0.0076) | -0.0569*** (0.0071) |
| Urban population rate (urban) | -0.1131*** (0.0037) | -0.1123*** (0.0050) | -0.1134*** (0.0037) | -0.1127*** (0.0036) |
| Institutional factors (institution) | 0.0072*** (0.0008) | 0.0071*** (0.0008) | 0.0096*** (0.0014) | 0.0040*** (0.0015) |
| Inflation rate (inflation) | -0.0001 (0.0003) | -0.0001 (0.0003) | -0.0001 (0.0003) | -0.0001 (0.0003) |
| Trade openness (trade) | 0.0465*** (0.0020) | 0.0447*** (0.0019) | 0.0673*** (0.0111) | 0.0463*** (0.0020) |
| Government expenditure (gov_size) | 0.0803*** (0.0175) | 0.1191*** (0.0188) | 0.0884*** (0.0180) | -0.0687 (0.0540) |
| (Per capita GDP)*(institutional factors) | | -0.0001*** (0.0000) | | |
| (Trade openness)*(institutional factors) | | | -0.0039* (0.0020) | |
| (Government expenditure)*(institutional factors) | | | | 0.0268*** (0.0102) |
| Middle East/North Africa dummy | 0.0131*** (0.0038) | 0.0144*** (0.0038) | 0.0117*** (0.0041) | 0.0163*** (0.0041) |
| Sub-Saharan Africa dummy | -0.0635*** (0.0036) | -0.0613*** (0.0038) | -0.0624*** (0.0036) | -0.0642*** (0.0037) |
| Constant | 0.1326*** (0.0066) | 0.1407*** (0.0080) | 0.1158*** (0.0104) | 0.1514*** (0.0098) |
| Variance equation | | | | |
| Per capita GDP growth rate (ggdp) | -11.2246*** (1.5099) | -10.4754*** (1.4924) | -11.5865*** (1.5941) | -12.2896*** (1.4802) |
| Square of per capita GDP growth rate (ggdp ²) | 54.2254*** (9.4590) | 51.3985*** (9.9130) | 52.9146*** (9.5697) | 31.1090** (12.6309) |
| Institutional factors (institution) | -0.3585*** (0.0641) | -0.2610*** (0.0650) | -0.3853*** (0.1195) | -0.3290** (0.1382) |
| Inflation rate (inflation) | -0.0000 (0.0432) | 0.0008 (0.0401) | -0.0001 (0.0460) | 0.0007 (0.0364) |
| Trade openness (trade) | 1.3582*** (0.1903) | 1.3200*** (0.1975) | 0.9465 (0.7488) | 1.4252*** (0.1972) |
| Government expenditure (gov_size) | -1.1285 (1.5732) | 1.4230 (1.6549) | -1.8955 (1.6212) | -2.5742 (4.4807) |
| (Per capita GDP)*(institutional factors) | | -0.0052*** (0.0012) | | |
| (Trade openness)*(institutional factors) | | | 0.0793 (0.1454) | |
| (Government expenditure)*(institutional factors) | | | | 0.0634 (0.8687) |
| Middle East/North Africa dummy | 0.1954 (0.2634) | -0.0997 (0.2756) | 0.2832 (0.2939) | 0.2849 (0.2931) |
| Sub-Saharan Africa dummy | 0.7247*** (0.2554) | 0.6311** (0.2493) | 0.6959*** (0.2650) | 0.6881** (0.2734) |
| Constant | -7.0228*** (0.2562) | -7.4025*** (0.2721) | -6.7813*** (0.5148) | -7.0071*** (0.5963) |
| σ_{t-1}^2 | 0.9794*** (0.0685) | 0.9701*** (0.0709) | 0.9696*** (0.0704) | 0.9907*** (0.0697) |
| σ_{t-2}^2 | 0.0290 (0.0213) | 0.0288 (0.0230) | 0.0472** (0.0230) | 0.0384* (0.0214) |
| Log likelihood | 2568.169 | 2571.747 | 2569.431 | 2567.721 |
| Turning point of growth | 10.35% | 10.19% | 10.95% | 19.75% |
| Number of observations | 1575.0000 | 1575.0000 | 1575.0000 | 1575.0000 |

Notes:

1. The numbers in parentheses are standard errors.

2. The asterisks ***, **, and * are 1%, 5%, and 10% of significance levels, respectively.

Table 2 (continued): GS and its volatility (ARCH-M estimation)

Dependent variable: log(GS)

| Sample period: 1984-2008 | Law and Order (13) | Law and Order (14) | Law and Order (15) | Law and Order (16) |
|---|--------------------------|--------------------------|--------------------------|--------------------------|
| Independent variables | | | | |
| GS volatility (σ^2) | -0.6869*** (0.2507) | -0.6748*** (0.2536) | -0.8522*** (0.2712) | -0.7344*** (0.2295) |
| Per capita GDP growth rate (ggdp) | 0.2184*** (0.0197) | 0.2005*** (0.0208) | 0.1869*** (0.0211) | 0.2062*** (0.0203) |
| Age dependency (age_dep) | -0.0676*** (0.0084) | -0.0723*** (0.0091) | -0.0535*** (0.0083) | -0.0648*** (0.0084) |
| Urban population rate (urban) | -0.1175*** (0.0041) | -0.1114*** (0.0050) | -0.1122*** (0.0042) | -0.1175*** (0.0042) |
| Institutional factors (institution) | 0.0037*** (0.0008) | 0.0058*** (0.0010) | 0.0085*** (0.0012) | 0.0054*** (0.0017) |
| Inflation rate (inflation) | -0.0001 (0.0003) | -0.0001 (0.0004) | -0.0001 (0.0003) | -0.0001 (0.0003) |
| Trade openness (trade) | 0.0392*** (0.0022) | 0.0419*** (0.0020) | 0.0781*** (0.0076) | 0.0397*** (0.0023) |
| Government expenditure (gov_size) | 0.1314*** (0.0191) | 0.1658*** (0.0196) | 0.1277*** (0.0202) | 0.1755*** (0.0470) |
| (Per capita GDP)*(institutional factors) | | -0.0001*** (0.0000) | | |
| (Trade openness)*(institutional factors) | | | -0.0077*** (0.0015) | |
| (Government expenditure)*(institutional factors) | | | | -0.0101 (0.0101) |
| Middle East/North Africa dummy | 0.0077* (0.0040) | 0.0038 (0.0041) | 0.0029 (0.0041) | 0.0059 (0.0041) |
| Sub-Saharan Africa dummy | -0.0641*** (0.0046) | -0.0655*** (0.0046) | -0.0678*** (0.0046) | -0.0652*** (0.0046) |
| Constant | 0.1564*** (0.0076) | 0.1476*** (0.0086) | 0.1242*** (0.0089) | 0.1483*** (0.0106) |
| Variance equation | | | | |
| Per capita GDP growth rate (ggdp) | -10.5614*** (1.3169) | -10.5179*** (1.3502) | -10.3832*** (1.3962) | -11.1770*** (1.4312) |
| Square of per capita GDP growth rate (ggdp ²) | 36.4855*** (12.1188) | 32.9940*** (11.3850) | 37.6185*** (10.6327) | 55.4063*** (9.3069) |
| Institutional factors (institution) | -0.2780*** (0.0534) | -0.0969 (0.0685) | -0.2190** (0.1059) | -0.1294 (0.1350) |
| Inflation rate (inflation) | -0.0019 (0.0433) | 0.0014 (0.0320) | -0.0007 (0.0386) | -0.0027 (0.0543) |
| Trade openness (trade) | 1.3922*** (0.1732) | 1.2319*** (0.2026) | 1.4119** (0.6142) | 1.3708*** (0.1771) |
| Government expenditure (gov_size) | -1.4190 (1.5088) | 1.2015 (1.6251) | -2.9324* (1.5925) | 2.4713 (3.1683) |
| (Per capita GDP)*(institutional factors) | | -0.0072*** (0.0015) | | |
| (Trade openness)*(institutional factors) | | | -0.0352 (0.1464) | |
| (Government expenditure)*(institutional factors) | | | | -0.9158 (0.7640) |
| Middle East/North Africa dummy | 0.5284** (0.2471) | 0.2392 (0.2637) | 0.6406*** (0.2440) | 0.4576* (0.2398) |
| Sub-Saharan Africa dummy | 1.0064*** (0.2316) | 0.8859*** (0.2361) | 1.0089*** (0.2310) | 1.0977*** (0.2168) |
| Constant | -7.4486*** (0.2474) | -7.9929*** (0.2575) | -7.4336*** (0.3891) | -8.0310*** (0.4621) |
| σ_{t-1}^2 | 0.9632*** (0.0697) | 0.9805*** (0.0716) | 0.9460*** (0.0704) | 0.9821*** (0.0708) |
| σ_{t-2}^2 | 0.0303 (0.0227) | 0.0348 (0.0216) | 0.0573** (0.0263) | 0.0106 (0.0207) |
| Log likelihood | 2564.962 | 2572.066 | 2570.38 | 2568.339 |
| Turning point of growth | 14.47% | 15.94% | 13.80% | 10.09% |
| Number of observations | 1575.0000 | 1575.0000 | 1575.0000 | 1575.0000 |

Notes:

1. The numbers in parentheses are standard errors.

2. The asterisks ***, **, and * are 1%, 5%, and 10% of significance levels, respectively.

Figure 1: The different shapes of GS paths

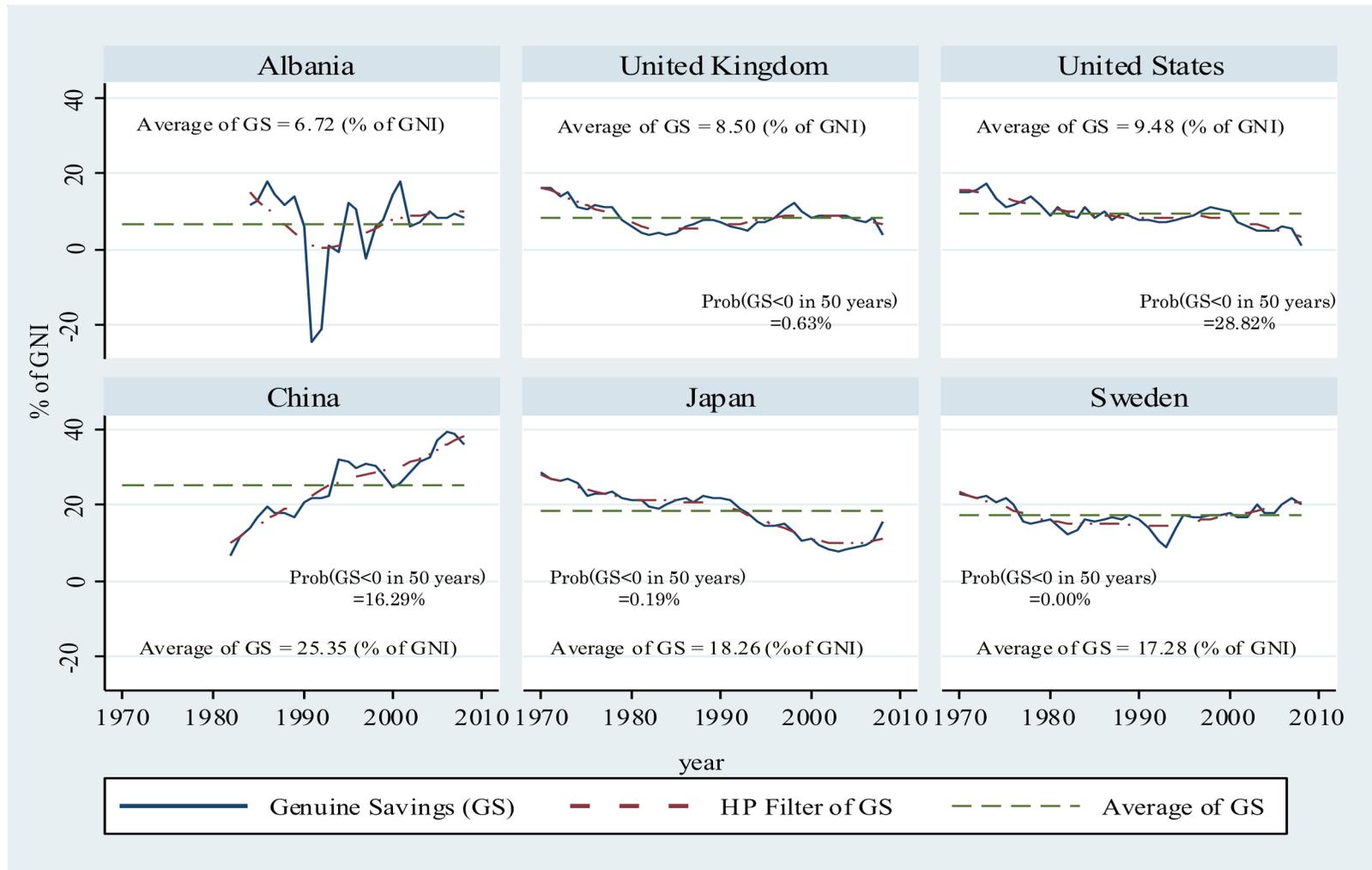


Figure 2: The relationship between institutions and sustainability

