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Abstract

In this paper, we introduce a new variable called *Internal Violence Index (IVI)* and study its effects on economic growth both theoretically and empirically. The first part builds a stochastic endogenous growth model which demonstrates that Internal Violence harms economic growth. On the theoretical side, this paper is the first to introduce a fully-micro-founded endogenous economic growth model that illustrates the explicit effect of Internal Violence on long-run growth in a stochastic dynamic optimization in continuous time framework. On the empirical side, this paper is also the first to employ Linear Regressions and Instrumental Variables Estimations techniques to empirically study the impact of Internal Violence on economic growth. The empirical results corroborate the theoretical predictions that Internal Violence acts negatively on economic growth. The negative impact of Internal Violence on growth are maintained when we use alternative measurements of Internal Violence and subsamples of Least Developed Countries (LDCs) and Non Least Developed Countries.

Keywords: Linear Regressions; Instrumental Variables Estimations; Endogenous Growth Theory; Stochastic Dynamic Optimization in Continuous Time; Internal Violence Index; Internal Armed Conflict, Criminality, Terrorism, Political Violence

JEL Classification: C61, C63, K14, K38, O41, O47, O50

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1 Introduction

The notion of Internal Violence is a wide-ranging view that encompasses internal armed conflicts, criminality, terrorism and political violence. The idea of Internal Violence is thus broader than the concepts of civil war or political violence as traditionally conceived in economic growth models. In many growth models, violence is only confined to civil war or political violence, each of which analyzed separately. The view point of Internal Violence is that all forms of violence can hinder economic performance in general and economic growth in particular. In fact, any possible combination of these four elements listed above can potentially harm economic growth. This may not be transparent in many developed countries where violence is, in most cases, low. But in developing countries, and particularly in Least Developed Countries (LDCs), where violence, in various forms, is intense and prevalent, we can observe, in many cases, that economic activity is hampered by violence. Therefore, to account for a more complete and broad notion, it is important to combine the four elements into a single measurement and study its impact on growth. High Internal Violence destroys physical and human capital, hampers the welfare of societies, augments capital flight and brain drain, reduces efficiency and total factor productivity, increases mortality, lessens consumption and investment, . . . , all of which negatively influence the growth rate.

Collier (1999) is one of the pioneering works on the effects of civil war on economic growth. He found that civil war has huge impacts on the composition and the level of GDP. Civil war causes growth to shrink by 2.2%. This, because civil war decreases GDP and engenders a continuous loss of capital stock by devastation, reduction of savings and capital flight. The impact of civil war on economic activity is not uniform. Sectors that are intensive in capital and transactions diminish more quickly while those with differing features grow rapidly.

Bodea and Elbadawi (2008) use a two-step procedure to examine the effect of organized political violence on economic growth. In the first step, they separately compute three measurements of political violence (riots, coups and civil war) by employing a multinomial model. In the second step, they utilize a dynamic panel data GMM estimation method to analyze the impact of their separate predicted probabilities of political violence on growth. They discover that organized political violence, particularly civil

war, harms long-run economic growth.

Abadie and Gardeazabal (2008) is one of the seminal studies on the consequences of terrorism on economic performance in general and on foreign direct investment in particular. They perform both theoretical and empirical analyses. Their theoretical model demonstrates that, despite being a small portion of the total economic risk, terrorism have a huge effect on the distribution of capital between economies. Terrorism diminishes the anticipated return on investment in addition to augmenting uncertainty. Consequently, if the global economy is appropriately integrated allowing financiers to branch out other kinds of nation state risks, variations in the magnitude of terrorism engender huge relocations of capital between nations. Their econometric estimations show that, despite taking into account other kinds of nation state risks, terrorism generates a fall in net foreign direct investment. They find that the impact of terrorism is very high because net foreign direct investment drops by 5% of GDP if the terrorism risk rises by one standard deviation.

Detotto and Otranto (2010) use a state space technique to examine the impact of crime on economic growth. They discovered that crime hinders economic growth. They found that economic growth in a month falls by 0.00040% if the crime rate increases by 1%. Their estimations additionally demonstrate that the economic costs of crime show a very important static element.

Similarly to the works cited above, this paper examines the connection between internal armed conflicts, criminality, terrorism, political violence and economic growth. But instead of analyzing the individual effect of each of the previous elements on growth, it combines them into a single concept called *Internal Violence*. It is the first study to merge all these four elements in a single notion and explore its impact on economic growth both theoretically and empirically. Specifically, it makes several contributions. On the theoretical side, this paper is the first to introduce a fully-micro-founded endogenous economic growth model that illustrates the explicit effect of Internal Violence on long-run growth in a stochastic dynamic optimization in continuous time framework. On the empirical side, the paper has many innovations. First, we use the new database on the Internal Violence Index (IVI) created by Feindouno, Goujon and Wagner (2016) to empirically capture the notion of *Internal Violence*. Second, since we are dealing with

cross-section data for the Internal Violence Index (IVI), we employ Linear Regressions and Instrumental Variables Estimations techniques to perform our growth regressions. The instrumental variables estimations employ an external instrument instead of internal instruments generally used in this literature. This theoretical model, this variable and instrumental variable have not been used in previous studies. The theoretical endogenous growth model demonstrates that Internal Violence decreases economic growth. The econometric results confirm the theoretical previsions that Internal Violence affects growth negatively. This result remains unchanged when we perform various robustness checks including: heteroscedasticity corrections, alternative measurements of the Internal Violence Index (IVI), subsamples of Least Developed Countries (LDCs) and Non Least Developed Countries, and instrumental variables estimations techniques.

The remaining of the paper is organized in the following manner: the first section presents some stylized facts, the second gives the theoretical model, the third section exposes the empirical investigations and the last part concludes.

2 Stylized Facts

In this section, we provide some stylized facts on the relationship between Internal Violence and economic growth.

Figure 1 gives the real GDP per capita level[1] during the civil wars in Liberia and Burundi respectively. For Liberia, the graph is relative to the first Liberian civil war that took place from 1989 to 1997. For Burundi, the graph is relative to the Burundian civil war that happened from 1993 until 2005. Mostly, in both graphics, we observe that the level of real GDP per capita is falling at high rates during the years of civil war. This gives us an evidence that civil war, in particular, and Internal Violence, in general, reduce growth drastically. We will show later in the text, that this stylized fact is something that our theoretical model is able to predict.

Figure 2 exhibits the real GDP per capita growth rate in function of the Internal Violence Index (IVI). The first graph gives a linear fit while the second provides a non-parametric fit. Both graphics clearly illustrate that there exists a negative connection between the real GDP per capita growth rate and the Internal Violence Index (IVI). This means that an increase in Internal Violence tends to be associated with a decrease in the growth rate. We will show below, that this stylized fact is something that our econometric estimations are able to demonstrate.

3 Theoretical Model

In this section, we expose the theoretical model and illustrate how the main equations are obtained.

3.1 Model Specification

Our model is an extension of Barro (1990) model to a continuous time stochastic framework. The model presumes identical individuals, meaning that they have similar preference parameters. Therefore, we can employ the representative-agent hypothesis within which the analysis is done from the decisions of one agent. The agent picks out a con-

[1] In purchasing power parity (PPP).

sumption path that maximizes the expected value of the present value of his lifetime utility function[2] subject to some dynamic and other constraints, and the initial value of capital stock. His optimization program is given by:

$$\underset{c(t)}{\text{Max}}\mathbb{E}_0\left(\int_0^{\infty}\frac{e^{\rho(-t)}c(t)^{\gamma}}{\gamma}\,dt\right) \tag{1}$$

Subject to:

$$dk(t) = \Big(A(1-\tau)g(t)^{\alpha}k(t)^{1-\alpha} - c(t) - \delta k(t)\Big)dt - A\sigma(1-\tau)g(t)^{\alpha}k(t)^{1-\alpha}dw(t) \tag{2}$$

$$g(t) = A\tau g(t)^{\alpha}k(t)^{1-\alpha} \tag{3}$$

And

$$k(0) = k_0 \text{ is given}$$

In equation (1), $c(t)$ is consumption, $\frac{1}{1-\gamma}$ measures the constant intertemporal elasticity of substitution in consumption, ρ represents the subjective rate of time preference. We have $\rho > 0$ and $0 < \gamma < 1$. The functional form of the felicity function has also been considered by Kamien and Schwartz (1991), and Boucekkine, Pintus and Zou (2018). Equality (2) gives the law of motion of broad capital stock. It is an Ito stochastic differential equation (SDE) process. In this equation, τ is income tax, A is total factor productivity, $k(t)$ is broad capital stock (physical and human capitals among others), $g(t)$ is productive government spending, $w(t)$ is a Wiener Process and σ is the volatility or instability of broad capital stock. In this SDE, the drift term says that broad capital stock increases through an augmentation of production[3] minus consumption and depreciation. The diffusion term, demonstrates that broad capital stock is reduced by Internal Violence. Here Internal Violence is modeled as an unfortunate random outcome that negatively affect broad capital stock. Hence, the reduction effect is modeled by the negative diffusion. Since Internal Violence is composed of internal armed conflicts, criminality, terrorism and political violence, it continuously exerts a negative effect on broad capital. In fact, when there is Internal Violence, for example civil war, terrorism, riots, criminality, . . . , in developing countries, assets of many kinds are destroyed and expropriated; skilled people are killed; people flee the country; roads, buildings and factories are demolished;

[2]The agent lives forever.

[3]Output exhibits constant returns to scale to broad capital stock and productive government spending together but is decreasing returns to scale in each factor taken separately.

financial assets flee the country; saving and investment are lessened; etc. All these factors make that broad capital stock is continuously and constantly reduced by Internal Violence since this concept contains many subcomponents: internal armed conflicts, criminality, terrorism and political violence. The addition of the impacts of each of these subcomponents makes that their cumulative effects are continuous and negative. This is captured in our model specification by the Wiener Process which is a continuous-time and continuous-state random process. Indeed, a Wiener Process $w(\mu, \sigma)$ with drift μ and diffusion σ has its state at time t following $\mathrm{N}\left(\mu t, \sigma\sqrt{t}\right)$. This is also why we did not model equation (2) as jump process. In equation (2), we assume the following conditions on the parameters: $0 < \alpha < 1, 0 < \delta < 1, 0 < \tau < 1$ and $0 \leq \sigma \leq 1$. The next expression (3) tells us that productive government spending is financed by income tax, which is the constant tax rate, τ, multiplied by output, $Ag(t)^{\alpha}k(t)^{1-\alpha}$. The last expression says that initial capital stock, k_0, is given. Labor supply is inelastic and constant. We assume $L(t) = 1$, thus all variables are expressed in per capita term.

In order to solve the above model, we will adopt the social planner solution method. To this end, we solve for $g(t)$ in equation (3) and substitute in equality (2).

$$dk(t) = \left((\tau - 1)\tau^{\frac{\alpha}{1-\alpha}}\left(-A^{\frac{1}{1-\alpha}}\right)k(t) - c(t) - \delta k(t)\right)dt + \sigma(\tau - 1)\tau^{\frac{\alpha}{1-\alpha}}A^{\frac{1}{1-\alpha}}k(t)dw(t) \tag{4}$$

This allows us to write the Stochastic Hamilton-Jacobi-Bellman (SHJB) equation for our model:

$$\begin{aligned}\rho V(k(t)) = \underset{c(t)}{\mathrm{Max}}\Bigg(V'(k(t))\left((\tau - 1)\tau^{\frac{\alpha}{1-\alpha}}\left(-A^{\frac{1}{1-\alpha}}\right)k(t) - c(t) - \delta k(t)\right) \\ + \frac{1}{2}\sigma^2(\tau - 1)^2\tau^{\frac{2\alpha}{1-\alpha}}A^{\frac{2}{1-\alpha}}k(t)^2V''(k(t)) + \frac{c(t)^{\gamma}}{\gamma}\Bigg)\end{aligned} \tag{5}$$

In this last equation, $V(k(t))$ is the Value Function of Bellman. The other variables and parameters are defined as above.

3.2 Economic Equilibrium

Taking the first order conditions of equation (5), we get:

$$c(t) = V'(k(t))^{\frac{1}{\gamma-1}} \tag{6}$$

Replacing this expression in equality (5) and simplifying, we obtain:

$$\begin{aligned} &2\left(k(t)\left(\left(\tau^{\frac{1}{1-\alpha}} - \tau^{\frac{\alpha}{1-\alpha}}\right)A^{\frac{1}{1-\alpha}} + \delta\right)V'(k(t)) + \frac{(\gamma-1)V'(k(t))^{\frac{\gamma}{\gamma-1}}}{\gamma} + \rho V(k(t))\right) \\ &= \sigma^2(\tau-1)^2\tau^{-\frac{2\alpha}{\alpha-1}}A^{-\frac{2}{\alpha-1}}k(t)^2V''(k(t)) \end{aligned} \tag{7}$$

As in Boucekkine et al. (2018), we will choose this functional form for our guess of the solution of the previous equation.

$$V(k(t)) = \frac{\Omega^{1-\gamma}k(t)^\gamma}{\gamma} \tag{8}$$

Substituting this function in equality (7) and doing lots of algebra and simplifications, we find:

$$\Omega = \frac{1}{\frac{1}{2}\gamma\sigma^2(\tau-1)^2\tau^{-\frac{2\alpha}{\alpha-1}}A^{-\frac{2}{\alpha-1}} - \frac{\gamma(\tau-1)\tau^{\frac{\alpha}{1-\alpha}}A^{\frac{1}{1-\alpha}}}{\gamma-1} + \frac{\gamma\delta+\rho}{1-\gamma}} \tag{9}$$

This value of Ω allows us to find the equations of interest in our study after many tedious algebra, substitutions and simplifications. Hence, the Ito process stochastic differential equation (SDE) for broad capital stock is given by:

$$dk(t) = -\frac{k(t)\left(\Omega\left(\tau^{\frac{1}{1-\alpha}} - \tau^{\frac{\alpha}{1-\alpha}}\right)A^{\frac{1}{1-\alpha}} + \delta\Omega + 1\right)}{\Omega}dt + \sigma(\tau-1)\tau^{\frac{\alpha}{1-\alpha}}A^{\frac{1}{1-\alpha}}k(t)dw(t) \tag{10}$$

where $k(0) = k_0$. Similarly, the Ito process for consumption is:

$$dc(t) = -\frac{c(t)\left(\Omega\left(\tau^{\frac{1}{1-\alpha}} - \tau^{\frac{\alpha}{1-\alpha}}\right)A^{\frac{1}{1-\alpha}} + \delta\Omega + 1\right)}{\Omega}dt + \sigma(\tau-1)\tau^{\frac{\alpha}{1-\alpha}}A^{\frac{1}{1-\alpha}}c(t)dw(t) \tag{11}$$

where $c(0) = \frac{k_0}{\Omega}$. Equation (11) gives us the expression for the growth rate in our economy. From this equality, we see that the growth rate is function of only the parameters of the model, time and the Wiener process. Hence the growth rate is endogenous in the sense that it is engendered from inside the system as a direct outcome of internal mechanisms. It changes as time varies and it is stochastic.

By the same token, the equation for the Value Function is provided by:

$$
\begin{aligned}
&dV(t) \\
&\quad = \frac{\gamma V(t)\left((\tau-1)\Omega\tau^{-\frac{2\alpha}{\alpha-1}}A^{-\frac{2}{\alpha-1}}\left((\gamma-1)\sigma^2(\tau-1)-2\tau^{\frac{\alpha}{\alpha-1}}A^{\frac{1}{\alpha-1}}\right)-2\delta\Omega-2\right)}{2\Omega}dt \\
&\qquad + \gamma\sigma(\tau-1)\tau^{\frac{\alpha}{1-\alpha}}A^{\frac{1}{1-\alpha}}V(t)dw(t)
\end{aligned} \tag{12}
$$

where $V(0) = \frac{\Omega^{1-\gamma}k_0^{\gamma}}{\gamma}$.

3.3 Numerical Simulations

In order to perform the numerical experiments, we first calibrate the parameters. We take these parameters mostly from the literature. $\delta = 0.05$, $\rho = 0.02$ and $\alpha = 0.67$ are from Barro and Sala-i Martin (2004). $A = 1$ and $k_0 = 2$ are normalizations. $\tau = 0.25$ is set to be similar to the ratio of tax revenues over GDP as in most countries in the World. $\gamma = \frac{1}{3}$ is computed from the survey of Thimme (2017). We set the volatility or instability of broad capital stock to $\sigma = 0.75$ because broad capital stock is highly volatile in periods of intense violence as typically is the case in most developing countries.

From these calibrated values of the parameters and variables, we numerically checked that the transversality condition for our model is verified and satisfied. That is:

$$
\lim_{t\to\infty}\mathbb{E}(V(k(t),t)) = \lim_{t\to\infty}\mathbb{E}\left(e^{\rho(-t)}V(k(t))\right) = 0 \tag{13}
$$

Figure 3 gives the evolution of broad capital stock (equation (10)) through time. We simulate 3 realizations of the trajectories for convenience. We see that broad capital stock is falling. The model clearly predicts what we expected. That is, when there is Internal Violence, buildings, roads, factories, . . . , are destroyed; qualified people are killed; people flee the country; financial capital flees abroad; saving and investment are reduced; etc. All these factors make that broad capital stock shrinks and falls. This is what this figure is illustrating.

Figure 4 provides the evolution of consumption (equation (11)) through time. As previously, we simulate 3 realizations of the trajectories. We observe that consumption is falling during periods of Internal Violence. This happens because when there is high Internal Violence, broad capital stock falls; saving and investment diminish; economic agents are uncertain about the future; etc. All these factors cause consumption to plunge.

This feature of the theoretical model is what we illustrated in our stylized facts in figure 1. This also happens because mean consumption is diminishing and its variance (uncertainty) is augmenting as illustrated in figure 5.

The Value Function is, to some extent, related to the Welfare of the agent in our model since it represents the choice of the agent of a consumption path that maximizes the expected value of the present value of his lifetime utility function. Figure 6 gives the evolution of the Value Function (equation (12)) through time. As before, we simulate 3 realizations of the trajectories. Here also we perceive that the Value Function is decreasing. This is an indication that when there is Internal Violence, the Welfare of the citizens in the country is, to a certain degree, deteriorating.

4 Empirical Investigations

This section presents the estimation methods, the data and variables, and the econometric results.

4.1 Estimation Methods

To empirically analyze the effect of the Internal Violence Index (IVI) on growth, we estimate the following econometric model:

$$grgdpcap_i = \mu_0 + \phi \ln\left(gdpcap_{i,0}\right) + \alpha\, IVI_i + \boldsymbol{\beta'} \boldsymbol{x_i} + \varepsilon_i \tag{14}$$

where $grgdpcap_i$ is the growth rate of real GDP per capita; $\ln\left(gdpcap_{i,0}\right)$ pinpoints the logarithm of the initial value of real GDP per capita; IVI_i is the Internal Violence Index (IVI); $\boldsymbol{x_i}$ illustrates a vector of control variables: logarithm of general government final consumption expenditures over GDP, logarithm of openness (exports + imports over GDP), logarithm of terms of trade (exports prices over imports prices), logarithm of 1 + the inflation rate, logarithm of domestic credit to private sector over GDP (financial development), initial human capital, reciprocal of initial life expectancy, logarithm of initial fertility rate and democratic accountability; ε_i is the error term; i specifies the countries.

Since the data on the Internal Violence Index (IVI) is a cross-section database, we use ordinary least squares (OLS) and instrumental variables regressions techniques to estimate equation (14). These two estimation methods, particularly the instrumental variables technique, allow us to consistently estimate the impact of the Internal Violence Index (IVI) on economic growth. We suspect Internal Violence to be an endogenous variable. We think that there might be a reverse causality going from economic performance to Internal Violence. For instance, bad economic performance can lead to high Internal Violence. To instrument Internal Violence, we employ the fact that we have two independent measurements of Internal Violence both measured with errors. In fact, when there is Internal Violence like civil war, it becomes very difficult and problematic to accurately measure economic aggregates including violence itself. This makes that Internal Violence is measured with some degree of noise in the data, hence with errors. To consistently estimate the impact of the Internal Violence Index (IVI) on economic growth we use the fact that we have two independent measurements on Internal Violence: the first coming from Feindouno et al. (2016) and the second coming from the *International Country Risk Guide* (ICRG). We then instrument the first measurement by the second. Below, we give more details on how each of these two variables is computed. For more details on this instrumentation technique, see Ashenfelter and Krueger (1994) and Wooldridge (2013).

4.2 Data and Variables

The Internal Violence Index (IVI) data are created by Feindouno et al. (2016) at the FERDI (Fondation pour les Études et Recherches sur le Développement International). It is a blended quantitative measurement. It is comprised of four main clusters: internal armed conflicts, criminality, terrorism, and political violence. The internal armed conflicts cluster includes the following variables: deaths due internal armed conflicts and internally displaced people. The criminality cluster is composed of homicides. The terrorism cluster contains: terrorist incidents, deaths due to terrorism and injuries due to terrorism. The political violence cluster comprehends: assassinations, purges and riots. This dataset captures the notion of Internal Violence we theorized earlier because it encompasses internal armed conflicts, criminality, terrorism, and political violence. All the four elementary components are regularized according to a min-max technique to obtain

four measures that vary between 0 and 100. This implies that the composite Internal Violence Index (IVI) also varies between 0 and 100. Three weighting schemes are used to compute three measurements of the Internal Violence Index (IVI). The first utilizes a modest arithmetic average with the identical mass of 0.25 allocated to the four clusters and the similar weight given to the constituents in every cluster. The corresponding variable is named in this paper as *Internal Violence Index* 1. The second measurement gives uneven masses for the variables in clusters 1, 3, and 4 while keeping equivalent masses at cluster level. The corresponding variable is named in this paper as *Internal Violence Index* 2. The third measurement employs a quadratic average to compute scores at the cluster level while preserving equal masses at clusters and variables levels. The corresponding variable is named in this paper as *Internal Violence Index* 3. See Feindouno et al. (2016) for more additional details on how each of these three measures are calculated.

Our second measurement of Internal Violence comes from the *International Country Risk Guide (ICRG)*. In this database, it is called *Internal Conflict*. We use this variable as an instrument in our regressions. This variable varies between 0 and 12. It is composed of the following subparts: Civil War/Coup Threat; Terrorism/Political Violence; and Civil Disorder. We observe that this variable also captures the notion of Internal Violence we theorized earlier. See the *ICRG Methodology* documentation available through the Internet for more additional details on how this variable is computed.

The sample of study is a cross-section data that contain 77 developing countries from 2008 to 2012 with 23 Least Developed Countries (LDCs) and 54 Non Least Developed Countries. The choice of the sample is based on the availability of data, the choice of the variables of the study and because the Internal Violence Index (IVI) is available only for developing countries. The data essentially come from the World Bank (World Development Indicators, 2014), the Fondation pour les Études et Recherches sur le Développement International (FERDI, 2016), the International Country Risk Guide (ICRG, 2014) and the Penn World Tables 8.0.

4.3 Econometric Results

In this part, we will present the main estimation results and the robustness analysis.

4.3.1 Main Estimation Results

Table 1 gives the estimation results of the relationship between the Internal Violence Index (IVI) and growth without correction of heteroskedasticity for all countries. In this table, the coefficient of initial real GDP per capita is significant and negative in all regressions. The negative coefficient indicates conditional convergence with respect to real GDP per capita. This convergence is conditional in that it concludes that the growth rate of real GDP per capita is bigger the initial real GDP per capita is small, only if the other regressors are kept constant. The coefficient indicates that conditional convergence is very high because it is carried out at a rate of 1.40% per year[4]. All eight equations show that the Internal Violence Index is statistically significant at all conventional levels and have the expected sign. This implies that an augmentation of the Internal Violence Index diminishes the growth rate. The above-mentioned results, empirically corroborate what we have found in the theoretical part. Specifically, this means that when there is high Internal Violence, broad capital stock falls; saving and investment diminish; economic agents are uncertain about the future; etc. All these factors cause the growth rate to plunge. This feature of the estimations results is what we illustrated in our stylized facts in figure 2. Our findings illustrate that, the negative effect of the Internal Violence Index on growth is robust to the introduction of different control variables. In fact, through the eight equations we have varied the introduction of the control variables but the coefficient of the Internal Violence Index retains its expected sign and is always statistically significant. The magnitude of the effect of the Internal Violence Index on growth is very high. Referring to regression (4), a rise in the Internal Violence Index by 100 percentage point decreases the growth rate by 3.53 percentage points. This is a very high value, suggesting that the Internal Violence Index has a huge diminishing impact on growth. This outcome suggests that reducing Internal Violence stimulates growth. We observe that the standard errors of the coefficients of the Internal Violence Index are relatively small. This implies that the corresponding confidence intervals, though not reported, are tinier meaning that the coefficients of the Internal Violence Index are estimated with great precision. The number of observations are stable in all eight equations, hence the phenomenon we are studying covers most of our sample. The

[4]From equation (5).

R-squared is reasonable in all equations. Fertility and the reciprocal of life expectancy negatively affect growth while democracy and terms of trade enhance growth. These last outcomes was found by many empirical growth studies.

Now we turn to the usual tests in linear regressions. All tests use equation (3) of Table 1. The Skewness/Kurtosis tests for Normality give us an adjusted *chi*2(2) statistic of 4.01 with a p-value of 0.1345. We cannot therefore reject the normality assumption of the residuals. The White's test for heteroskedasticity provides a *chi*2(35) statistic of 35.34 with a p-value of 0.4523. We see that we cannot reject the null hypothesis of homoskedasticity. Nevertheless, we use White's method of correction for heteroskedasticity, in the subsequent estimations, for safety reasons, since White's test is not very powerful (a bit favorable to H_0). This correction does not modify the coefficients obtained by OLS but, on the other hand, we have corrected Student tees without bias. The Durbin-Wu-Hausman augmented regression test for endogeneity [5] gives an $F(1, 55) = 0.00$ with a p-value of 0.9818. The large p-value specifies that OLS is not inconsistent. This test demonstrates that the Internal Violence Index (IVI) is not endogenous in our sample. This result shows that the very strong link between the Internal Violence Index (IVI) and growth is not due to the simultaneity bias. Nonetheless, we correct for endogeneity in the robustness subsection since endogeneity might also be an economic hypothesis problem. The Ramsey RESET test for the detection of a bad specification of the functional form as well as the omission of relevant variables provides an $F(21, 35) = 0.91$ with a p-value of 0.5849. This result illustrates that we cannot reject the hypothesis of a good specification of the model. We utilize the successive Chow test[6] to detect an endogenous break point. The command objectively told us that there is no break point at all conventional significance levels in our sample.

Table 2 provides the regressions with correction of heteroskedasticity. In this Table, we have changed the specifications of the individual equations compared to Table 1 in order to control for the robustness of our estimations to the introduction of different control variables. Similar to Table 1, we see that there is conditional convergence in all equations. As in the first Table, the Internal Violence Index (IVI) have a negative and statistically

[5] Sometimes also called Nakamura Nakamura's test.

[6] I introduce a new Stata command named **suchowtest** for performing this test. The command is downloadable at: `https://ideas.repec.org/c/boc/bocode/s457536.html`.

significant coefficient in all estimations. This demonstrates that Internal Violence harms economic growth even if we take heteroskedasticity into account. Thus correcting for heteroskedasticity does not alter our main results we found in the first Table. The initial fertility rate continues to negatively affect growth while democratic accountability and terms of trade still boost economic growth. The number of observations is stable in all regressions and the R-squared is fairly acceptable.

4.3.2 Robustness Analysis

In Table 3, we give the estimation results using the alternative measures of the Internal Violence Index (IVI). In this Table, we have included one by one the alternative measurements of the Internal Violence Index (IVI). We see that all the two Internal Violence Index (IVI) variables affect negatively and significantly economic growth. As in the first two Tables, the effect of Internal Violence is very high and is approximately similar to its magnitudes we found in those Tables. The coefficients remain approximately stable across all two equations. The number of countries are comparable to the ones we have in Table 2. The initial GDP per capita and the initial fertility rate are still statistically significant, and keep their expected respective signs. The results found here suggest that changing the way the Internal Violence Index (IVI) is computed does not change the conclusions we found in Table 1 and 2.

Table 4 presents the results of the estimations for the Least Developed Countries (LDCs). Similarly to the previous regressions, the Internal Violence Index (IVI) influences negatively economic growth. As in the main estimations, the effect of Internal Violence is very high. Referring to equation (6), we observe that the magnitude of the impact of the Internal Violence Index (IVI) has approximately doubled compared to the main estimations. Consequently, Internal Violence is very harmful to the Least Developed Countries (LDCs). The coefficients of the Internal Violence Index (IVI) are roughly stable in all eight equations. According to many statisticians, the overall rule of thumb is that we must have approximately at least 10 to 20 observations per estimated coefficient in a regression. Hence the number of countries for our Least Developed Countries (LDCs) sample is fairly reasonable and acceptable. The results for the Least Developed Countries (LDCs) corroborates those found in our main regressions. The initial fertility

rate continues to have a negative impact on growth. There is no conditional convergence among the Least Developed Countries (LDCs).

Table 5 gives the regressions for the Non Least Developed Countries (NLDCs). The results in this Table illustrate that the Internal Violence Index (IVI) acts negatively and significantly on growth in the Non Least Developed Countries (NLDCs). As in the main estimations, we observe that the effect of the Internal Violence Index (IVI) is very large. The number of observations is fairly big and stable. We thus have a good representative subsample. As in the main regressions, the initial fertility rate and the reciprocal of life expectancy affect growth negatively while the terms of trade exert a positive impact on economic growth. Contrarily to the Least Developed Countries (LDCs), there is conditional convergence among the Non Least Developed Countries (NLDCs). The results we found in the main estimations are thus maintained for the Non Least Developed Countries (NLDCs).

Table 6 gives the instrumental variables estimations results for all countries with the variable *Internal Violence Index* 3. The results of the Underidentification test statistic illustrate that all our equations are identified. This means that the excluded instrument is pertinent, implying that it is linked with the endogenous variable. The Weak identification test shows that the identification is strong as the F statistic is above 10% of OLS bias. Hence our excluded instrument is not weakly correlated with the endogenous regressor[7]. The Hansen J statistic is not reported because it is always zero since our model is exactly identified. This is because we use only one instrument. The number of observations is large and stable in all equations. All eight equations in Table 6 show that the Internal Violence Index (IVI) is statistically significant at all conventional levels and have the expected negative sign. We observe that the effect of the Internal Violence Index (IVI) is too high. Referring to regression (4), a rise in the Internal Violence Index (IVI) by 100 percentage point decreases the growth rate by 5.04 percentage points. This is 1.43 times larger than what we had in the estimations without correction of heteroskedasticity. Consequently, our instrumentation technique might reduce the attenuation bias. We observe that the standard errors of the coefficients of the Internal Violence Index (IVI) are very small. This implies that the corresponding confidence intervals, though not reported,

[7]The first-stage regressions results are available upon request.

are tinier meaning that the coefficients of the Internal Violence Index (IVI) are estimated with great precision. The use of instrumental variables in the estimations makes it possible to say that the negative relationship between the Internal Violence Index (IVI) and economic growth seems to go from the Internal Violence Index (IVI) towards growth and not the reverse. Our estimations corroborate those found in the literature of civil war and political violence by using a different broader measurement of Violence, and also an instrumental variable regression technique. As in the main estimations, there is conditional convergence in all equations. The reciprocal of life expectancy continues to harm growth while democratic accountability still boosts economic growth.

5 Conclusion

This paper examines the relationship between the Internal Violence Index (IVI) and economic growth both theoretically and empirically. The theoretical part shows that an increase in Internal Violence hinders the growth rate in the centralized economy. Using Linear Regressions and Instrumental Variables Estimations techniques, we find that the Internal Violence Index (IVI) has a strong negative impact on growth. A rise in the Internal Violence Index (IVI) by 100 percentage point decreases the growth rate by 5.04 percentage points. The use of instrumental variables in the estimations makes it possible to say that the negative relationship between the Internal Violence Index (IVI) and economic growth seems to go from the Internal Violence Index (IVI) towards growth and not the reverse. The robustness checks illustrate that the negative impact of the Internal Violence Index (IVI) on growth is stable to the use of alternative measurements of the Internal Violence Index (IVI) and on subsamples of Least Developed Countries (LDCs) and Non Least Developed Countries (NLDCs).

Though the results found were informative, some extensions could be made. If panel data of the Internal Violence Index (IVI) were available, we could use Large Heterogeneous Cross-Sectionally Dependent Panel Data Estimations Methods to empirically analyze the impact of Internal Violence on growth. Concerning the theoretical model, a jump-diffusion model could also give us more insights on how Internal Violence affects growth. These avenues of research are left for our future studies.

From economic policy perspectives, the results illustrate that Internal Violence could have negative impacts on growth and that efforts made to reduce it might relaunch saving, investment and growth.

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Figure 1: Real GDP per Capita Level during Civil War

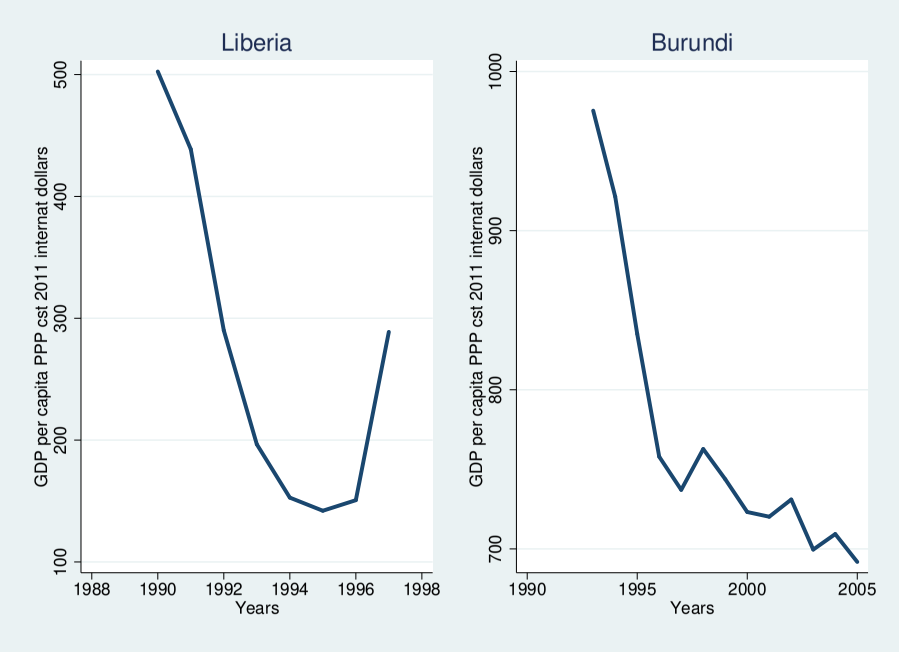

Figure 2: Real GDP per Capita Growth Rate in Function of the Internal Violence Index

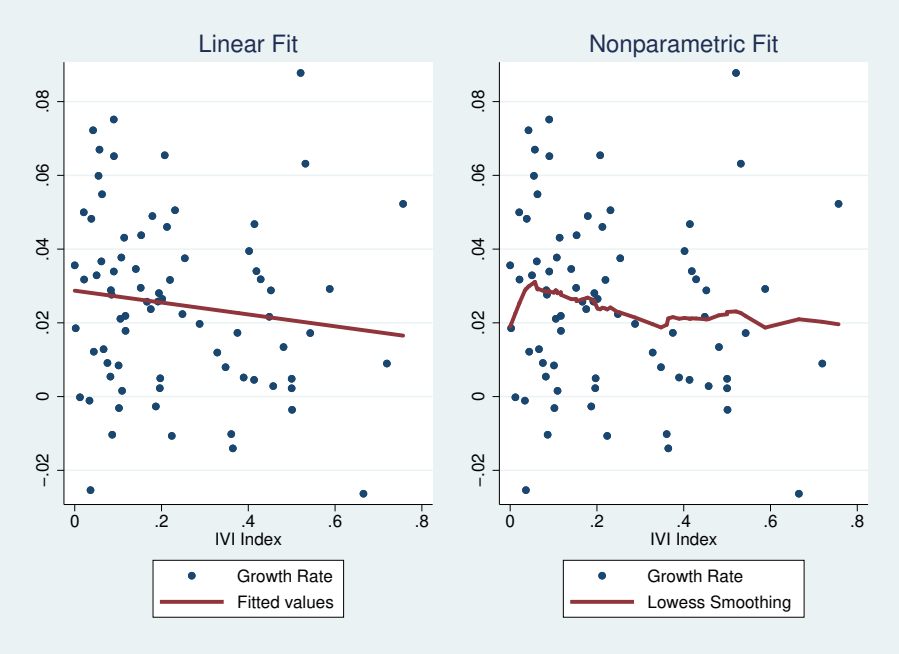

Figure 3: Evolution of Broad Capital Stock

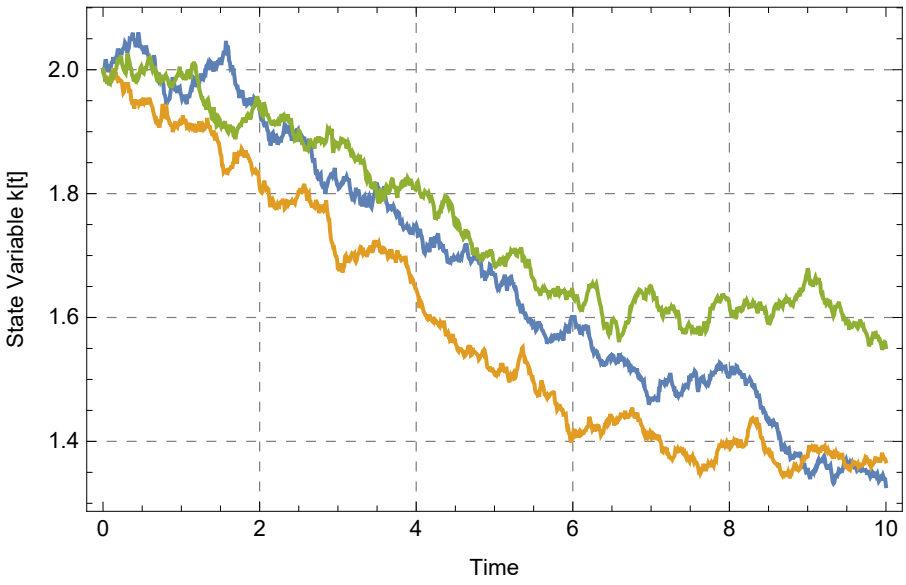

Figure 4: Evolution of Consumption

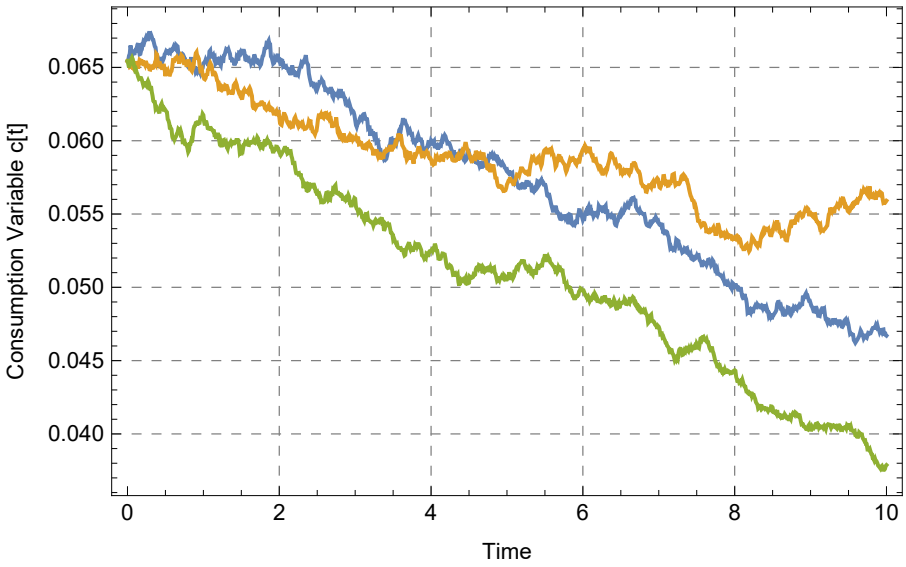

Figure 5: Evolution of the Moments of Consumption

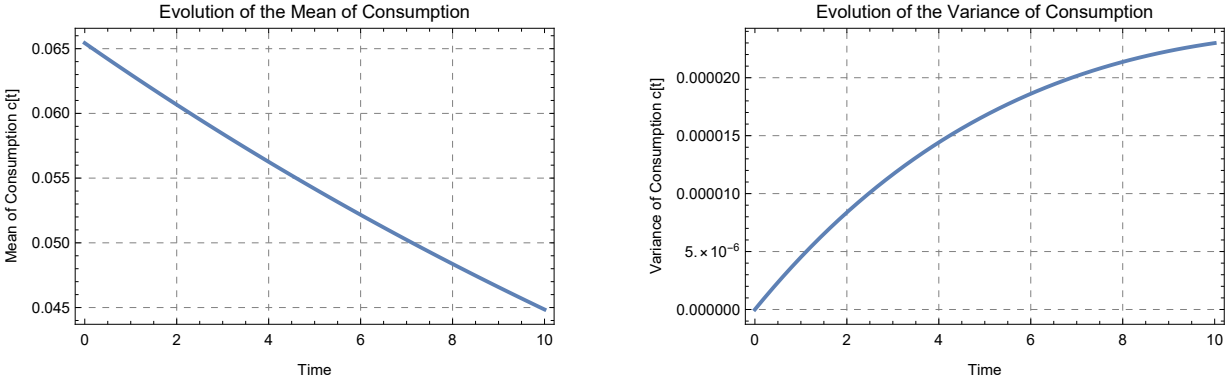

Figure 6: Evolution of the Value Function

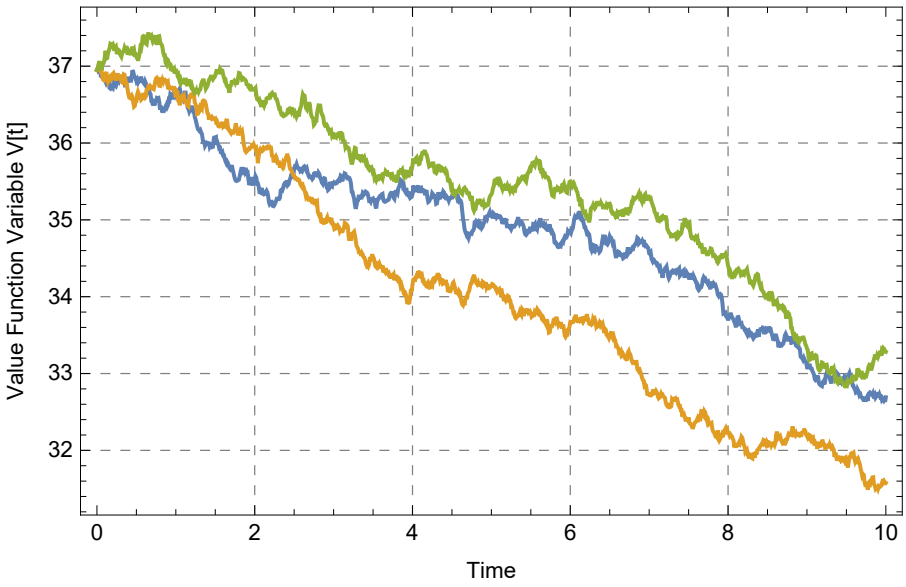

Table 1: Regressions without Correction of Heteroskedasticity

Dependent Variable: Growth Rate of Real GDP per Capita								
Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Initial GDP per Capita	-0.0103***	-0.00612**	-0.0109***	-0.0103***	-0.0135***	-0.0102***	-0.0104***	-0.0111***
	(0.00344)	(0.00303)	(0.00334)	(0.00335)	(0.00331)	(0.00313)	(0.00313)	(0.00339)
Internal Violence Index 3	-0.0317**	-0.0327**	-0.0346**	-0.0353**	-0.0270*	-0.0317**	-0.0336**	-0.0323**
	(0.0154)	(0.0160)	(0.0152)	(0.0161)	(0.0136)	(0.0153)	(0.0154)	(0.0144)
Initial Fertility Rate	-0.0345***		-0.0379***	-0.0299***	-0.0425***	-0.0342***	-0.0420***	-0.0445***
	(0.0100)		(0.0136)	(0.0109)	(0.00983)	(0.00938)	(0.0121)	(0.0132)
Government Consumption	0.00101							0.00411
	(0.00975)							(0.00994)
Openness	-0.00348			-0.00304		-0.00352	-0.00230	
	(0.00678)			(0.00686)		(0.00671)	(0.00681)	
Democratic Accountability	0.00349*	0.00414*	0.00381*	0.00364*	0.00458**	0.00353*	0.00368*	0.00362*
	(0.00204)	(0.00211)	(0.00200)	(0.00203)	(0.00196)	(0.00200)	(0.00200)	(0.00202)
Reciprocal of Life Expectancy		-3.087*	-1.287	-1.247				
		(1.643)	(1.682)	(1.695)				
Inflation		0.0797	0.0161	0.0362				
		(0.0788)	(0.0779)	(0.0753)				
Financial Development		0.00379	-0.00579				-0.00559	-0.00646
		(0.00477)	(0.00567)				(0.00543)	(0.00551)
Terms of Trade					0.0161**			
					(0.00732)			
Constant	0.140***	0.113**	0.159***	0.150***	0.164***	0.136***	0.140***	0.157***
	(0.0495)	(0.0438)	(0.0446)	(0.0442)	(0.0352)	(0.0344)	(0.0346)	(0.0504)
Observations	64	64	64	64	64	64	64	64
R-squared	0.267	0.187	0.286	0.275	0.320	0.267	0.280	0.281

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 2: Regressions with Correction of Heteroskedasticity

Dependent Variable: Growth Rate of Real GDP per Capita								
Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Initial GDP per Capita	-0.0105***	-0.0104***	-0.0111**	-0.0111***	-0.0116***	-0.0110**	-0.0138***	-0.0125***
	(0.00349)	(0.00340)	(0.00425)	(0.00333)	(0.00368)	(0.00458)	(0.00406)	(0.00418)
Internal Violence Index 3	-0.0317*	-0.0336*	-0.0323*	-0.0338**	-0.0301*	-0.0326*	-0.0296*	-0.0330*
	(0.0168)	(0.0192)	(0.0168)	(0.0169)	(0.0167)	(0.0189)	(0.0167)	(0.0168)
Initial Fertility Rate	-0.0422***	-0.0420***	-0.0445***	-0.0387***	-0.0395***	-0.0441***	-0.0492***	-0.0386***
	(0.0104)	(0.0105)	(0.0132)	(0.0117)	(0.0102)	(0.0146)	(0.0130)	(0.0138)
Openness		-0.00230						
		(0.00788)						
Financial Development	-0.00591	-0.00559	-0.00646	-0.00616	-0.00624	-0.00630	-0.00450	-0.00694
	(0.00594)	(0.00659)	(0.00630)	(0.00593)	(0.00591)	(0.00678)	(0.00622)	(0.00627)
Democratic Accountability	0.00376	0.00368	0.00362	0.00378	0.00341	0.00363	0.00451*	0.00336
	(0.00237)	(0.00251)	(0.00253)	(0.00238)	(0.00245)	(0.00259)	(0.00256)	(0.00258)
Government Consumption			0.00411			0.00409	0.00274	0.00390
			(0.0110)			(0.0112)	(0.0107)	(0.0113)
Reciprocal of Life Expectancy				-1.239				-1.241
				(1.289)				(1.335)
Initial Human Capital					0.00702			0.00575
					(0.00632)			(0.00669)
Inflation						0.00703		
						(0.0797)		
Terms of Trade							0.0149**	
							(0.00640)	
Constant	0.141***	0.140***	0.157**	0.161***	0.131***	0.155**	0.175***	0.167**
	(0.0388)	(0.0379)	(0.0657)	(0.0366)	(0.0383)	(0.0705)	(0.0626)	(0.0702)
Observations	64	64	64	64	64	64	64	64
R-squared	0.278	0.280	0.281	0.286	0.286	0.281	0.328	0.294

Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 3: Using Alternative Measurements of Internal Violence

Dependent Variable: Growth Rate of Real GDP per Capita		
Regressors	(1)	(2)
Initial GDP per Capita	-0.0119***	-0.0118***
	(0.00423)	(0.00424)
Internal Violence Index 2		-0.0318*
		(0.0185)
Internal Violence Index 1	-0.0352*	
	(0.0202)	
Reciprocal of Life Expectancy	-1.248	-1.213
	(1.305)	(1.298)
Initial Fertility Rate	-0.0409***	-0.0410***
	(0.0138)	(0.0138)
Government Consumption	0.00535	0.00527
	(0.0111)	(0.0111)
Financial Development	-0.00700	-0.00710
	(0.00614)	(0.00611)
Democratic Accountability	0.00353	0.00352
	(0.00248)	(0.00247)
Constant	0.178**	0.177**
	(0.0688)	(0.0688)
Observations	64	64
R-squared	0.266	0.264

Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 4: Regressions for the Least Developed Countries (LDCs)

Dependent Variable: Growth Rate of Real GDP per Capita								
Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Initial GDP per Capita	-0.00904	-0.00855	-0.00851	-0.00819	-0.00864	-0.00844	-0.00875	-0.00869
	(0.0147)	(0.0127)	(0.0152)	(0.0132)	(0.0168)	(0.0153)	(0.0149)	(0.0166)
Internal Violence Index 3	-0.0612*	-0.0688*	-0.0690*	-0.0651*	-0.0685*	-0.0692*	-0.0681*	-0.0684*
	(0.0316)	(0.0351)	(0.0337)	(0.0343)	(0.0350)	(0.0364)	(0.0330)	(0.0323)
Initial Human Capital	0.00593				0.00150		0.00120	0.00154
	(0.0186)				(0.0216)		(0.0204)	(0.0210)
Reciprocal of Life Expectancy	3.179	2.654	2.653	3.135	2.649	2.661	2.642	2.644
	(2.802)	(2.442)	(2.495)	(2.749)	(2.736)	(2.613)	(2.585)	(2.600)
Initial Fertility Rate	-0.0664***	-0.0739***	-0.0742***	-0.0700***	-0.0734***	-0.0741***	-0.0734***	-0.0735***
	(0.0166)	(0.0132)	(0.0116)	(0.0158)	(0.0155)	(0.0135)	(0.0151)	(0.0139)
Government Consumption	-0.00793			-0.00661				
	(0.00951)			(0.0108)				
Financial Development	-0.0163	-0.0184	-0.0186	-0.0172	-0.0184	-0.0184	-0.0183	-0.0184
	(0.0129)	(0.0127)	(0.0113)	(0.0130)	(0.0129)	(0.0127)	(0.0127)	(0.0113)
Inflation		0.00420			0.00206	0.00314	0.00380	
		(0.114)			(0.128)	(0.124)	(0.117)	
Openness			-0.000527		-0.000702	-0.000453		-0.000757
			(0.0126)		(0.0145)	(0.0137)		(0.0132)
Constant	0.0823	0.125	0.125	0.0958	0.122	0.124	0.123	0.122
	(0.130)	(0.101)	(0.117)	(0.139)	(0.119)	(0.119)	(0.0957)	(0.115)
Observations	23	23	23	23	23	23	23	23
R-squared	0.468	0.456	0.456	0.465	0.457	0.456	0.456	0.457

Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 5: Regressions for the Non Least Developed Countries (NLDCs)

Dependent Variable: Growth Rate of Real GDP per Capita								
Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Initial GDP per Capita	-0.0156***	-0.0142***	-0.0126***	-0.0108***	-0.00997***	-0.0137***	-0.0140***	-0.0147***
	(0.00387)	(0.00379)	(0.00392)	(0.00367)	(0.00358)	(0.00390)	(0.00375)	(0.00381)
Internal Violence Index 3	-0.0307*	-0.0324*	-0.0316*	-0.0302*	-0.0347*	-0.0357**	-0.0329*	-0.0296*
	(0.0172)	(0.0176)	(0.0187)	(0.0174)	(0.0202)	(0.0174)	(0.0174)	(0.0164)
Reciprocal of Life Expectancy	-2.203	-2.792*		-3.872*	-3.560*	-2.426	-2.813*	-2.939*
	(1.838)	(1.640)		(2.079)	(1.932)	(1.616)	(1.625)	(1.591)
Initial Fertility Rate	-0.0366**	-0.0320*	-0.0394**			-0.0319**	-0.0324**	-0.0331**
	(0.0150)	(0.0161)	(0.0158)			(0.0154)	(0.0156)	(0.0160)
Government Consumption	0.0110	0.00816	0.00532	0.00504	0.00407	0.0111	0.00864	0.00983
	(0.0102)	(0.0115)	(0.0113)	(0.00955)	(0.0113)	(0.0106)	(0.0108)	(0.0107)
Terms of Trade	0.0134*			0.00819				
	(0.00742)			(0.00824)				
Financial Development	-0.00517	-0.00776	-0.00677		0.00102	-0.00695	-0.00769	-0.00864
	(0.00610)	(0.00698)	(0.00762)		(0.00700)	(0.00639)	(0.00694)	(0.00626)
Democratic Accountability	0.00309			0.00279	0.00209	0.00229		
	(0.00277)			(0.00285)	(0.00281)	(0.00271)		
Initial Human Capital		0.00171						0.00123
		(0.00795)						(0.00802)
Openness		-0.00399	-0.00560		-0.00284		-0.00389	
		(0.00718)	(0.00748)		(0.00832)		(0.00712)	
Constant	0.233***	0.226***	0.178***	0.178**	0.171**	0.222***	0.231***	0.237***
	(0.0647)	(0.0652)	(0.0547)	(0.0694)	(0.0681)	(0.0651)	(0.0577)	(0.0637)
Observations	49	54	54	49	49	49	54	54
R-squared	0.352	0.302	0.260	0.249	0.232	0.306	0.302	0.297

Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 6: Instrumental Variables Estimations

Dependent Variable: Growth Rate of Real GDP per Capita								
Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Internal Violence Index 3	-0.0463*	-0.0436*	-0.0412*	-0.0504*	-0.0463*	-0.0441*	-0.0408*	-0.0436*
	(0.0259)	(0.0255)	(0.0245)	(0.0275)	(0.0262)	(0.0247)	(0.0243)	(0.0247)
Initial GDP per Capita	-0.00684**	-0.00617*	-0.00765**	-0.00596*	-0.00640*	-0.00697**	-0.00718*	-0.00661*
	(0.00298)	(0.00324)	(0.00340)	(0.00305)	(0.00342)	(0.00340)	(0.00373)	(0.00373)
Reciprocal of Life Expectancy	-3.842**	-3.370**	-3.377*	-3.963**	-3.658*	-3.365**	-3.110	-3.145*
	(1.770)	(1.547)	(1.738)	(1.667)	(1.891)	(1.650)	(1.909)	(1.815)
Inflation		0.0947		0.0904		0.0953		0.0920
		(0.0920)		(0.0923)		(0.0958)		(0.0962)
Financial Development		0.00345	0.00368			0.00478	0.00401	0.00502
		(0.00665)	(0.00608)			(0.00642)	(0.00627)	(0.00664)
Democratic Accountability	0.00459*	0.00427*	0.00456*	0.00469*	0.00479*	0.00465*	0.00480*	0.00484*
	(0.00257)	(0.00236)	(0.00250)	(0.00262)	(0.00277)	(0.00251)	(0.00266)	(0.00267)
Terms of Trade	0.00410		0.00635	0.00324	0.00460	0.00612	0.00717	0.00680
	(0.00811)		(0.00722)	(0.00825)	(0.00838)	(0.00692)	(0.00733)	(0.00710)
Government Consumption					-0.00495		-0.00604	-0.00498
					(0.01000)		(0.0103)	(0.0104)
Constant	0.131**	0.118**	0.133**	0.121**	0.114	0.123**	0.112	0.106
	(0.0505)	(0.0484)	(0.0513)	(0.0503)	(0.0710)	(0.0507)	(0.0708)	(0.0704)
Observations	64	64	64	64	64	64	64	64
R-squared	0.154	0.180	0.171	0.166	0.158	0.188	0.177	0.192
P-value Underident. LM Stat.	0.000467	0.000241	0.000199	0.000648	0.000399	0.000211	0.000189	0.000179
F Stat. Weak Ident.	27.88	24.37	28.37	23.87	28.49	25.26	28.11	25.42

Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$