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Essays on Natural Resource Impact

Ilkin Aliyev

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Dedicated to my family

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Abstract

This dissertation consists of three essays on the impact of natural resources on economic and fiscal performance. The first chapter investigates the resource impact on economic growth using a non-parametric minimum-distance matching method. Countries are matched according to their observable characteristics, and the relative growth rates of GDP of each matched pair are computed. In this way, it is possible to analyze the impact of the resources on relative growth rates, rather than on absolute growth rates as has been done in previous studies. Assuming a correlation between observables and unobservables, the matching based on observables may control for unobservables as well. If this assumption is satisfied, matching allows us to control for more variables and to single out the direct effect of the resource abundance variable. The study uses different measures of resource abundance to check the robustness of such a relationship. The empirical results suggest that there is a strong negative relationship between the relative abundance of exhaustible resources and economic growth. For non-exhaustible resources, the results are mixed, with a frequent positive impact on relative growth. The contrary evidence found in Sala-i-Martin et al. (2004) is discussed, and the differences in methodology and estimation, which potentially may create differences in the results, are highlighted.

The second chapter analyzes fiscal policy procyclicality in resource-rich countries. A strong U-shaped relationship between the procyclicality of government capital expenditures and the resource richness measure comprised of the mineral exports share in total merchandise exports is obtained for developing countries. Such a

relationship is robust to different methodologies and various checks. Two hypotheses have been considered: first, the political economy hypothesis, and second, the borrowing constraints hypothesis. Empirical observations appear to be consistent with the hypotheses. A model has been built that is able to generate a U-shape effect combining political economy and borrowing constraint hypotheses. Arguably, with a model of simple settings such a U-shape relationship can be obtained and interpreted.

The third chapter investigates the role of natural resources in Azerbaijan's post-transition development using structural break analysis. In comparison to resource poor countries of the South Caucasian countries, Armenia and Georgia, the study finds that indeed Azerbaijan has thus far been able to use its oil and gas resources to outperform its neighbors in terms of per capita income growth. The results have also been confirmed using regression estimation. Further, fiscal procyclicality in these countries has been compared. Findings are consistent with the borrowing constraint alleviation and political economy hypotheses layed out in Chapter 2.

The dissertation contributes to the resource curse debate in the literature confirming the existence of the curse in developing countries. Despite the negative impact on economic growth and on fiscal procyclicality through political economy channels, the dissertation establishes the positive role of resource abundance on fiscal procyclicality through borrowing constraint alleviation. This is a new result, which has not been found in the previous literature on the subject.

Abstrakt

Tato disertační práce se skládá ze tří esejí na téma vlivu přírodních zdrojů na ekonomický a fiskální výkon. První kapitola disertační práce zkoumá vliv přírodních zdrojů na ekonomický růst s použitím ekonometrické metody matchingu. Používáme metodu neparametrického matchingu minimálních vzdáleností tak, že dochází ke spárování zemí na základě jejich pozorovatelných charakteristik a následnému odhadu relativní míry růstu každého přičleněného páru. Tento způsob nám umožní analyzovat vliv přírodních zdrojů na relativní růst, zatímco současná literatura je v tomto ohledu omezena na růst absolutní. Budeme-li předpokládat korelaci mezi pozorovatelnými a nepozorovatelnými charakteristikami, pak právě analýza na základě metody matchingu založená na pozorovatelných charakteristikách je schopna ohlídat také působení nepozorovatelných charakteristik. Při splnění tohoto předpokladu matching umožňuje ohlídat větší množství proměnných a zároveň vyjádřit přímý efekt proměnné hojnosti přírodních zdrojů. Používáme různé míry hojnosti přírodních zdrojů, abychom otestovali robustnost takového vztahu. Empirické výsledky ukazují, že zde existuje silný negativní vztah mezi hojností vyčerpatelných přírodních zdrojů a relativním ekonomickým růstem. Výsledek pro nevyčerpatelné zdroje je spíše smíšený s často pozitivním vlivem na ekonomický růst. Věnujeme se i rozdílnosti výsledků článku Sala-i-Martin et al. (2004), která je pravděpodobně způsobená odlišnou metodologií odhadu.

Druhá kapitola se zabývá procyklicitou fiskálních politik v zemích bohatých na suroviny. Zjistili jsme, že závislost procyklicity vládních kapitálových výdajů na míře surovinového

bohatství vyjádřené jako podíl exportu nerostných surovin na celkovém exportu je kvazikonvexní ve tvaru U. Tato závislost je robustní i v případě použití různých metodologií a jiných nemetodolgických úprav. Zabýváme se dvěma hypotézami vysvětlení tohoto vztahu: jednak hypotézou politické ekonomie a také hypotézou úvěrového omezení. Empirická pozorování se jeví jako konsistentní s těmito hypotézami. Sestavili jsme model, který umožňuje vytvořit efekt dané kvazikonvexní závislosti tvarované do U na základě hypotézy politické ekonomie a úvěrového omezení. Tvrdíme, že při použití takového modelu s jednoduchým nastavením můžeme danou kvazikonvexní do U tvarovanou závislost získat a zároveň ji interpretovat.

V této kapitole zkoumáme roli přírodních zdrojů v post-transitivním vývoji Ázerbájdžánu využitím analýzy strukturálních zlomů. Ve srovnání s Arménií a Gruzií, tedy jihokavkazskými zeměmi chudými na přírodní zdroje, zjišťujeme, že Ázerbájdžánu dopomohly zdroje ropy a zemního plynu k překonání svých sousedů v podobě růstu HDP per capita. Tyto výsledky byly taktéž potvrzeny využitím standardní regresní analýzy.

Chapter 1

Understanding the Resource Impact Using Matching

1.1. Introduction

Much research has been done on whether a natural resource boom leads to higher economic growth and a wealthier nation, or whether it is a sort of curse which in the long run slows down the overall economic development of a resource-rich country (as described in Stevens 2003). In the series of papers by Sachs and Warner (1995, 1997, 1999, and 2001), it is argued that there is a strong negative link between resource abundance and economic growth at a cross-country level. Following their work, different authors have tried to understand and explain this phenomenon. Interestingly, the majority of the empirical work supports a negative relationship between resource abundance and economic growth (Sachs and Warner 1995, 1997, 1999, 2001; Auty 2001a; Gylfason et al. 1999).

In contrast to the supporters of the resource curse phenomenon, there is much literature that argues against it. In most cases, these critiques are similar to those made for general cross-country growth regressions. Manzano and Rigobon (2001), and Lederman and Maloney (2002) point out econometric issues related to such cross-country regressions. The main concerns are the omitted variable bias and the endogeneity problem. Using fixed-effect estimation which accounts for these issues, they find that the impact of resources on growth is not statistically significant. However, the resource abundance measure is relatively time invariant, and differencing in fixed-effect estimation may decrease the variance of the resource variable, which may lead to an increase in the variance of the estimator.

This study aims to contribute to the literature and analyze the impact of resources on economic growth using a novel methodology. Unlike the previous literature on the subject, we focus on the relative growth rates rather than on the absolute growth rates of resource-rich countries. For every country we try to find similar-matched countries according to their observable characteristics, and estimate the relative growth rates for every matched pair of countries. Then, we estimate the impact of the relative resource richness on the relative growth rates, rather than on absolute growth rates as has been done in the literature. This allows an estimation of the under- or over-performance of the country depending on the abundance of its resources. Matching has an advantage over fixed-effect estimation, as differencing is performed between countries, but not according to time.

One of the main challenges in this study is to find a match for each resource-rich country. Here, we use the minimum vector distance matching (exact matching) shown in Dehejia and Wahba (2002). This simple method of matching two countries is based on minimized distance between the vectors of variables of these countries. In other words, the smaller the distance between the two vectors is, the more similar the countries are.

Contrary to the findings of the previous resource curse literature, Sala-i-Martin, Doppelhofer and Miller (2004) identify the fraction of GDP from mining as being among the 18 most robust variables affecting growth, and conclude that it has a positive impact on growth. They show that with more control variables included in the regression, the more significant is the resource impact on growth. This means that the mining variable requires other conditioning variables to show its full impact. In the current research, assuming correlation between observables and unobservables, the matching based on observables may control for unobservables as well. If this assumption is satisfied, matching allows to control for more variables and to single out the direct effect of the resource abundance variable. Further, we use different measures of resource abundance.

1.2. The Debate in the Literature

The series of papers by Sachs and Warner (1995, 1997, 1999, and 2001) have drawn attention to the empirical analysis of the link between resource abundance and economic growth. The most distinctive feature of Sachs and Warner's (henceforth, SW) work is empirical evidence of a robust negative relationship between resources and growth using an econometric approach. They label this phenomenon the "Resource Curse". The existence of such "unexpected" empirical evidence has been a motivation for the literature.

SW estimate a cross-country regression equation showing that per capita GDP growth negatively depends on resource abundance during the period of 1960-1990. As the measure of resource abundance, they use the share of primary exports to GDP. They argue that the negative link remains significant after controlling for different variables found in earlier growth literature.[1]

[1] SW use variables from Barro (1991), DeLong and Summers (1991), King and Levine (1993), Mankiw, Romer and Weil (1992).

Also, SW claim that the results are robust to the different measures of resource abundance and to the outliers. Three alternative measures of resource abundance are considered in their research: 1) the share of mineral production as percentage of GDP; 2) the percentage of primary exports out of total exports; and 3) the logarithm of land area per person. Despite differences in the measures of resource abundance, its impact on growth remains negative and statistically significant. As each observation has the same weight in regressions, SW exclude those observations that have high residuals to decrease the sensitivity of the results to a few observations.

Inspired by SW's work, the literature became focused on using econometric techniques to explain an adverse effect of resources on growth.[2] Among others, Gylfason, Herbertson and Zoega (1999) also analyze the relationship between growth and the size and volatility of the primary sector. They suggest an alternative measure of resource abundance in addition to that used by SW. Gylfason et al. (1999) test the primary sector labor share as a resource abundance measure and find evidence suggesting the existence of a „resource curse". The evidence clearly supports the results of SW.

In contrast, there is much literature that argues against the results of SW's work and the existence of a resource curse phenomenon. Most of these critiques are concentrated on the estimation methodology of the cross-country regressions used by SW, including omitted variable bias and endogeneity issues.

Manzano and Rigobon (2001) re-estimate SW's regressions using panel data. As they find similar results to SW's work, indicating a negative association between growth and resource abundance with panel data too, they point out a possible bias due to omitted variables and suggest using fixed-effect estimation. The fixed-effect estimation

[2] Stevens (2003) provides an extensive literature review on the subject.

eliminates the robustness of the resource abundance variable. This result allows them to conclude that there is significant omitted variable bias, which has been taken into account in the fixed-effect estimation. Manzano and Rigobon state, that over the past 30 years, production in the resource sector has been declining and they suggest focusing on the performance of non-resource GDP rather than total GDP, as the latter is directly linked to the resource sector itself. The use of non-resource GDP does not change the results significantly compared to the total GDP in the sense that the negative link is still present in cross-sectional and panel data estimation, but loses its significance once fixed-effect estimation is applied.

Lederman and Maloney (2002) are also aware of potential econometric issues related to SW's regressions. They challenge the sensitivity of SW's results in three ways: 1) using different time periods; 2) considering the presence of omitted variable bias using fixed-effect estimation; 3) acknowledging the presence of reverse causality. They show the negative effect of natural resource exports on growth only for the period between 1950 and 1989. However, using data from Maddison (1994), they obtain a positive effect of resource abundance for the periods 1820-1873 and 1913-1950, although their results are not statistically significant. Therefore, they claim that SW's results do not survive the test of time. Similarly to Manzano and Rigobon (2001), they find important bias and inconsistency problems due to omitted country-specific variables. Here, after using fixed-effect estimation, the natural resource abundance variable effect on GDP is not statistically significant and sometimes has a positive sign.

In addition to the econometric concerns of SW's work, there are other authors who draw attention to the proper identification of the resource abundance variable, such as Stijns (2001), Ding and Field (2005), and Cerny and Filer (2007). They suggest the differentiation of two key aspects of the resource-abundant country regarding natural resources: natural resource dependence and natural resource endowment. Here, the general argument is that although dependence on natural resources retards growth, natural resource endowment is positively related to growth.

Ding and Field (2005) obtain similar results when replicating the growth regressions with natural resource abundance variables that were used previously by SW and other authors. If natural resource capital per capita is used as a resource abundance measure, its effect on growth appears to be positive. However, they also estimate a recursive model to account for possible endogeneity between natural capital and growth, and they find that its effect on growth is statistically insignificant. Cerny and Filer (2007) achieve similar results. Specifically, in their study, when the natural resource endowment measure is used instead of the natural dependence measure, its impact on growth becomes insignificant. This result leads Cerny and Filer (2007) to claim that there is no such phenomenon as the resource curse.

Contrary to the findings of the previous resource curse literature, Sala-i-Martin, Doppelhofer and Miller (2004) identify the fraction of GDP in mining among the 18 most robust variables affecting growth, and find that it has a positive impact on growth. They use a novel methodology, Bayesian Averaging of Classical Estimates, to evaluate the robustness of growth regression variables. The authors acknowledge that this result is in contrast to what was obtained in the resource curse literature. They show that with more control variables included into the regression, the impact of resources on growth becomes positive and more significant. According to Sala-i-Martin et al. (2004), mining requires other conditioning variables to show its full impact.

The current research contributes to the literature by applying a novel methodology - matching - that could account for the omitted variable issue in the regression. Different from the fixed-effect estimation in the literature, matching does not reduce the variance of the resource abundance measure. Matching similar countries may lend assisst in controling for unobservables. An increase in the controls of unobservables may lead to results similar to Sala-i-Martin et al. (2004); that resource abundance has a positive effect on growth. Matching enables us to both account for omitted variable bias, and to underline the effect of resource abundance by putting more weight on similar countries.

1.3. Methodology

We employ a simple method of matching based on minimized distance between X vector of covariates. In other words, the smaller the distance between covariate vectors, the more similar the countries. The vector distance S between $X_i = (x_i^1, \ldots, x_i^N)$ for country *i* and $X_j = (x_j^1, \ldots, x_j^N)$ for country *j* is computed as:

$$S_{ij} = \sqrt{(x_i^1 - x_j^1)^2 + \ldots (x_i^N - x_j^N)^2} \qquad (1.1)$$

where N – is the number of variables (covariates) used to match the countries. It is important to note that the vector of covariates X does not include the resource variable as this is our focus variable.

We define a threshold value for the distance measure $\bar{S}$. Countries that have a distance below $\bar{S}$ are considered to be similar. There might be more than one country that is less than $\bar{S}$ distance from the country *i* under consideration. In this case, we obtain several matches for country *i*. The relative growth rates of country *i* with respect to country/ies *j* are obtained as follows:

$$\tilde{Y}_{ij} = Y_i - Y_j \text{ for all } j\text{'s where } S_{ij} \in [0, \bar{S}] \tag{1.2}$$

It is worth noting that in (1.2) all countries within this distance are weighted equally in computing the relative growth rates. However, potentially we could use weighting of the observations based on their closeness to the country under consideration.

The literature on resource impact on growth considers the following general form of the regression:

$$Y_{it} = \delta_0 + X'_{it}\beta + \alpha R_{it} + \eta_i + \varepsilon_{it} \tag{1.3}$$

where Y_{it} is per capita GDP growth rate of country *i* at time *t*, R_{it} is the resource abundance variable for the country *i* at period *t*, X_{it} represents all other variables that affect growth, η_i represents country-specific constant characteristics not captured in the estimation, δ_0 is a constant, and ε_{it} is an error term.

As already mentioned, the simple OLS estimation of (1.3) may suffer from omitted variable bias. The omitted variable bias issue may be solved using fixed-effect estimation as was applied by Manzano and Rigobon (2001) and Lederman and Maloney (2002). The fixed-effect estimation requires panel data with a minimum of two time periods. Differencing with respect to time accounts for country-specific unobservables, which is the potential cause of the bias.

The effect of the variable R_{it} on growth is of major interest in the resource impact literature. Potentially, this variable can be dichotomous, taking a unit value when the country is resource rich. However, in this case, a binary resource variable will not allow for the fixed-effect of estimation to be performed in order to eliminate the effect of the omitted variables, because differencing with respect to time will also eliminate any identifying variation in the binary resource variable.

In the literature, usually R_{it} is not a "dummy". As noted above, the most often used measures of resource abundance are shares of natural resource exports and/or natural resource production. In this case, differencing will not eliminate the identifying variation in the resource variable because it may change with time. However, the potential issue is the low variance of this variable across time for a resource-rich country. The resource-rich country may not have changes in its resource abundance if the time is more frequent. Further, differencing with respect to time may lead to an increase in the variance of the estimate $\hat{\alpha}$, which will make it difficult to draw inferences regarding resource impact. We conjecture that this is one of the reasons for the results of Manzano and Rigobon (2001) and Lederman and Maloney (2002) regarding the resource abundance variable being statistically insignificant.

In the current study, the main purpose of applying the matching procedure is to identify comparable countries. Using successful matching procedures will decrease the possibility of wrongly matched pairs, ensuring that the best matches are obtained. After identifying the optimal matches, we proceed to estimating the effect of resource abundance on the relative growth performance of the countries.

Here, the variable of interest will be the relative growth rates of a country with respect to similar countries computed as in (1.2), instead of the traditional absolute growth rate used in most of the growth regression literature. The use of relative growth rates will allow us to account for the issue of omitted variable bias in SW's regressions. If matching is performed based on observed country-specific characteristics, then the similarity of the matched pair may account for unobserved country-specific characteristics that cannot be included into the regression due to short samples and non-availability issues. In this case, the relative growth rates will not contain those unobservables because they will have been differenced out. This is one of the possible solutions to the omitted variable bias.

In this regard, matching possesses an advantage over fixed-effect estimation because the differencing is not performed with respect to time. Instead, by matching a resource-rich country with a resource-poor country that is similar to it, we underline the effect of the resources and at the same time eliminate the effect of the omitted country-specific variables. When countries are matched based on X, to account for omitted country-specific factors η_i, we presume that the population correlation is non-zero, $corr[X_{it}, \eta_i] \neq 0$. If the opposite is true, then matching based on X's cannot eliminate the omitted variable bias. If the correlation is significant, then we are able to account for more variables. We are aware of the fact, that depending on these correlations, such an approach may help to minimize the omitted variable bias issue, but may not solve it completely. However, we believe that this is a new methodology suggesting differencing in observations rather than in time by not decreasing the variance of the relatively time-invariant resource variable.

After computing relative growth rates on matched countries, we proceed with the estimation of the effect of R_{it} on those growth rates. Here, we estimate a simple linear regression model using relative resource richness as the only explanatory variable:

$$\tilde{Y}_{ijt} = \tilde{\eta}_{ij} + \alpha \tilde{R}_{ijt} + \tilde{\varepsilon}_{ijt} \qquad (1.4)$$

where, $\tilde{Y}_{ijt} = Y_{it} - Y_{jt}$, $\tilde{R}_{ijt} = R_{it} - R_{jt}$, $\tilde{\eta}_{ij} = \eta_i - \eta_j$ and $\tilde{\varepsilon}_{ijt} = \varepsilon_{it} - \varepsilon_{jt}$.

Different from (1.3), the above regression does not contain X_{it} and η_i.[3] Instead, these factors are used to identify the best matches. If matching is successful, then matching allows us to account for more control variables and omitted variables. If X is highly multidimensional, that it is practically impossible to include them all into the regression as explanatory variables. On the contrary, matching based on multidimensional X allows us to control for variables without including them into the regression.

An obvious alternative to the distance matching is the propensity score matching suggested by Rosenbaum and Rubin (1983). It is extensively used in micro-experimental studies where treatment and control groups are matched based on their observable

[3] Explicit derivation of the equation (1.4) from the equation (1.3) is described in the Appendix.

covariates. Propensity score matching uses the probability of being in the treatment group given a set of covariates. In the context of the current chapter, it would be interpreted as the probability of being resource rich given the observed characteristics. We think that such an interpretation is less intuitive, as resource richness is considered to be fairly exogenous, randomly assigned and predetermined. Moreover, the propensity score matching method implies the impact of observable covariates on the probability of being in the treatment group. However, in the distance matching this is not the case. In our view, a non-parametric matching is better suited to the purposes of this work, as being resource rich is considered not to be affected by any of those observed covariates.

In addition to the distance measure used in this chapter, other types of distance measures might be considered to calculate the distance between the countries, such as the Mahalanobis measure, a unitless distance measure in which distance between two vectors is normalized by the covariance. Our distance measure is the normalized Euclidean measure which is a reduced Mahalanobis measure in which the covariance matrix of covariates is the diagonal matrix diagonals consisting of ones. In order to use the Mahalanobis measure, one has to explore correlations among covariates in detail which exceeds the scope of this study.

1.4. Empirical results

1.4.1. Cross-country evidence

The initial step is to find matches for each country globally, and use exact matching, applying the dataset in Sala-i-Martin et al. (2004). By running many growth regressions with different explanatory variables, Sala-i-Martin et al. (2004) show that there are 18 variables which are robustly related to growth; the mining fraction of GDP is among these variables. We select all these variables to match the countries, excluding only the mining fraction of GDP–resource abundance variable, because in our case, resource abundance is our focus variable and we would like to match countries with different resource abundance levels to measure the impact of resource richness. Therefore, we have 17 variables for matching, listed in Table 1.1.[4]

Before implementing the minimum vector distance matching technique, we divide each variable by its standard deviation. As each of these variables has a different scale, applying such normalization would eliminate differences in scale. After normalization, we pick a country and find the distance between it and each other country. The smaller the vector distance is, the more similar the countries are.

We should note that we cannot find two countries with exactly the same values of X covariates, because there are a limited number of countries in the world. Therefore, we are only able to find the distance value closest to zero. We choose the threshold value for distance 0.1; that is, if the distance is less than 0.1 then the countries are similar. Applying such a threshold yields a different number of matches for different countries. In total, we found 390 cross-matches for 108 countries within a 0.1 distance (Table 1.2).

It is crucial to define what is meant by resource abundance. Sala-i-Martin et al. (2004) define the mining share of GDP as the resource abundance measure. Sachs and Warner (1995, 1997) consider primary exports as an indicator of resource richness. Primary sector products include agriculture, fishing, forestry, minerals and fuels. These primary products have different characteristics in terms of exhaustibility and renewability. Agricultural, fishing and forestry products are non-exhaustible and

[4] Please note that all the tables and graphs are at the end of the chapter.

renewable, however, mining and quarrying products are non-renewable and exhaustible in the predictable future. In this study, we separate exhaustible and non-renewable resources from non-exhaustible and renewable resources, and focus on both types, unlike Sachs and Warner (1995) and others. In our study, exhaustible resources include only mineral resources consisting of fuels, ores and metals. Having identified minerals as the focus natural resources, our resource abundance measure will be the mineral exports share of the total merchandise exports taken from the World Development Indicators 2007 by the World Bank covering the period 1960-2004.

After choosing different measures of resource abundance, we estimate the impact of relative resource abundance on relative growth. The estimation yields the results shown in Table 1.3. One can argue that the observations in our expanded sample are correlated. To avoid this, we use a bootstrapping method to estimate the standard errors of the coefficients. The table shows that there is either a strong negative or, in a few cases, no relationship between relative resource abundance and relative growth, depending on which resource abundance measure and time periods are selected. The only resource abundance measure that has a positive and significant impact on relative growth is the PXI70 variable.

In addition, as each pair of countries has a different degree of similarity based on the vector distance measure, we weight every observation (pair) by its assigned distance measure, applying weighted least squares (WLS) estimation using distance as the weighting criterion. The WLS estimation yields the results seen in Table 1.4.

Table 1.4 shows that the results are not significantly changed when using WLS estimation. This may indicate that the choice of threshold value as $\overline{S}$ is succesful, so that countries lying within that distance from a focus country may be comparable to it.

In Table 1.3 (and similarly in Table 1.4), the results (2)-(2) and (2)-(5) show that there is no relationship between growth and the share of exports of primary products in GNP (SXP), which is in contrast to claims by SW. Furthermore, (5)-(2) and (5)-(5) show a positive association between growth and the ratio of primary exports to total merchandise exports (PXI70). This clearly contradicts the claim that resource abundance slows economic growth.

On the other hand, the results (4)-(2) and (4)-(5) indicate that there is a strong negative link between growth and the share of mineral production in GDP (SNR), which is similar to SW's results, that resource abundance has a negative impact on growth. Additionally, the results (6)-(2), (6)-(5), (7)-(3) and (7)-(6) suggest that the mineral exports share of total merchandise exports (MINxx_yy) has a significant negative impact on growth.

In order to interpret these differences in results, it is important to understand the differences in the measures of resource abundance. We have considered two types of resource abundance measures based on: 1) primary products (like SXP and PXI70); and 2) mineral products (like SNR, MINING and MINxx_yy). Mineral products are perceived to be exhaustible. On the other hand, primary products include exhaustible and non-exhaustible resources as well.

According to the Standard International Trade Classification, primary products are wider-ranging than mineral products, and include: food and live animals (SITC 0), beverages and tobacco (SITC 1), crude materials, inedible, except fuels (SITC 2), mineral fuels, lubricants and related materials (SITC 3), animal and vegetable oils and fats (SITC 4) and non-ferrous metals (SITC 68).

We claim that the differences originate from the nature of the resource abundance measures: non-exhaustible resources may have a different impact on growth than exhaustible resources. The empirical evidence in this paper supports our claim, demonstrating that the resource measures based on primary products, which also include non-exhaustible resources, either have a positive impact on growth or have no impact at all. However, the empirical evidence with resource measures based on mineral resources suggests that there is a strong negative association between growth and resource richness.

Comparing the results with PXI70 (the share of primary exports in total merchandise exports) and MIN66_70 (the share of mineral exports in total merchandise exports), primary exports have a positive effect on growth, whereas mineral exports have a negative impact.

It is important to mention that the choice of the threshold is not mechanical. If one chooses the threshold, then a trade-off between the number of matches and the noise should be made. A higher threshold would potentially include less relevant matches into the analysis. We also weighted observations by their respective distance, and found no significant difference; the results remain robust. Increasing the threshold would include matches with smaller weight, which would impact results marginally under weighted least squares estimation. There is no apparent significant value added in reporting results with higher thresholds once weighted least squares methodology is applied. If the threshold is too small, then there would be with fewer observations.

Table 1.5 shows the regression results with the unique match for each country that has closest distance. In this case, there would be 87 observations. The results seem to hold compared to the previous results, indicating a negative association between mineral resource richness and growth. The impact of primary products on growth remains inconclusive as before. As expected, the standard errors became larger due to the significantly lower number of observations.

The estimation results with the matches within 0.05 distance are shown in Table 1.6. With the threshold of 0.05 the number of obtained matches decreases to 95, with 55 of them belonging to developed OECD countries. This may indicate that OECD countries are more similar to each other. Overall, in this estimation the results have changed dramatically. Mineral products seem to have no impact on growth, whereas primary products play a positive role in economic growth. It is likely that such different results are due to the matches under consideration. Almost all of the matches in the estimation within 0.05 distance are for developed OECD countries due to the unavailability of data for non-OECD countries. These results may indicate that the resource curse phenomenon is not applicable to developed countries, and indeed, resource richness may contribute to their growth.

1.4.2. Consistency check with Sala-i-Martin et al. (2004) results

In Table 1.3 (and Table 1.4), the results (1)-(1) show that there is no relationship between growth and the mining and quarrying fraction of GDP (MINING), which is contradictory to what has been claimed by Sala-i-Martin et al. (2004).

Sala-i-Martin et al (2004) (SM) have identified 18 variables that are robustly related to economic growth. Among those 18 variables, there is a resource variable, defined as the mining share of GDP, that has a positive impact on growth. This result contrasts with our results and with what has been found earlier by SW (1995, 1997, 2001), Gylfason (2001) and others. Sala-i-Martin et al. (2004) claim that by including more explanatory variables, the positive effect of resources on growth grows stronger. Therefore, it is important to justify our results in comparison to SM's results.

To do so, first of all, using SM's dataset we estimate growth regression (1.3) by including all 18 robust explanatory variables shown in SM. The regression estimation in Table 1.7 shows that, indeed, the mining share of GDP (resource variable) has a positive impact on growth confirming SM's results. Using the estimation results, we divide the growth rate of a country into two parts: *non-resource-based growth (NBG)* and *resource-based growth (RBG)* (including error term). After knowing the regression results of (1.3) we compute resource-based growth as follows:

$$RBG = Y_{it} - NBG = Y_{it} - \hat{\delta}_0 - X'_{it}\hat{\beta} = \hat{\alpha}R_{it} + \hat{\eta}_i + \hat{\varepsilon}_{it} \qquad (1.5)$$

SM's results show that resource abundance is positively related to growth; this implies that as resources increase, resource-based growth also increases, as shown in Figure 1.1. That is, the coefficient $\hat{\alpha}$ has a positive sign. We should mention that this result is sensitive to outliers. If we remove Botswana, which has a resource production share equal to 0.53, then the results are not significant. This may also indicate that the Sala-i-Martin et al (2004) results on the positive impact of resources on growth should be taken with a grain of salt.

As argued in Manzano and Rigobon (2001), there may be a significant omitted variable bias in such a regression. We therefore use a matching method to control for those omitted variables. The main assumption in using matching is that there is a correlation between observables and unobservables, and matching countries based on observables will help control for both observables and unobservables.

We apply the matching methodology to the obtained regression results, using the countries already matched in Table 1.3, and calculate relative resource-based growth rates and relative resource abundance. Interestingly, the sign of $\hat{\alpha}$ is negative, in opposition to the original regression (1.3) results (Figure 1.2).

Figure 1.2 shows that relative resource richness has a negative impact on the relative resource-based growth rate. If we assume that SM's regression is valid, then cross-sectional differencing should still yield a positive effect on relative growth rates. However, we obtain the opposite result – that the relative growth rate is negatively related to relative resource abundance. Using SM's dataset and SM's measure of resource abundance, we compare the results found earlier with other measures of resource abundance. Even using the same dataset, our results are in contrast to SM's results. This may point to an omitted variable problem in SM's estimation. This leads, in turn, to the conclusion that these differences in results are due to differences between our methodology and SM's methodology.

1.4.3. Time-series evidence

Here, we focus on understanding the resource impact from a time-series perspective. Having identified the matches, we would like to understand the relative GDP growths of the similar countries over time. To understand the effect of resource richness, we identify a country that has discovered significant resources so that we can analyze comparatively how the growth of this country has been affected with respect to a matched country.

We identify 14 countries that have experienced significant increases of resource export shares in total merchandise exports over the available dataset 1960-2003. We understand a significant increase to mean that in a particular year (we label it as a „break date“) the difference between one year's export share and that of following year is greater than 20%, and that this increase persists over the next 10 years. Those 14 countries are: Angola, Cameroon, the Republic of Congo, Ecuador, Egypt, Mauritania, Mexico, Morocco, Niger, Nigeria, Norway, Papua New Guinea, Senegal and Togo.

Table 1.8 depicts identified matches and break dates obtained as per the procedure. For example, Cameroon has been matched with 5 countries: Uganda, Namibia, Nigeria, Ghana and Cote d'Ivoire. As noted above, we find the year in which the first occurrence of the difference between next year's export share and the previous year's export share is greater than 20%; for Cameroon this is 1978. Figure 1.3 shows Cameroon's GDP per capita relative to each matched country. If we take the simple geometric average of per capita GDPs of matched countries, then the graph appears as in Figure 1.4. Here, year 0 coincides with the break date 1978.

For Mauritania we could not identify reasonable matches within an acceptable distance. For Papua New Guinea, although there are 4 matched countries, Western Samoa, Solomon Islands, Tonga, and Vanuatu, neither of these countries has GDP per capita data available in PWT. Therefore, we cannot display their graph of comparison with respect to matched countries. Likewise, we cannot consider Angola from the time-series perspective, as there is no per capita GDP data available in PWT.

Figures 1.3 through 1.22 (for each "treatment" country), and Figure 1.23 (for all countries average) also show interesting patterns. After a break date, there is an almost decade-long GDP per capita over performance for resource-rich countries, followed by a long period of under-performance. At a later stage, relative GDP performance stabilizes at a certain level. Stabilization of the relative per capita GDP can be at a higher or lower level compared to the pre-break date level. This may tell us that there is no long-term growth effect of the resources. Arguably, from Figure 1.23 we can derive the conclusion that there is long term positive level effect on income on average.

The literature on resource impact focuses mainly on the income growth effects, and its impact on level of income, standard of living and wealth have not attracted comparable attention from researchers. Another contribution of the current work is that we conclude that there is an overall positive level effect of the resources on income.

It is true that, in order to understand the impact of resources from a time-series perspective, careful analysis of every case is required. Obviously, resource impact, the length of the impact and resources' interaction with other factors vary for each country. Once an approximate or average lag structure of the resource impact and other interactions are known, one could pursue panel regression analysis. This could be a topic for separate further research.

1.5. Concluding remarks

In this paper, we analyze the impact of resource richness on a country's GDP per capita performance compared to countries that are similar to it. Using non-parametric minimum vector distance matching yields up to 390 matched pairs depending on which measure of resource abundance is used. After identifying the matched pairs, we estimate the effect of resource abundance differences on GDP per capita growth differences. We use different resource abundance measures as well as different time periods.

Cross-country evidence shows that the relationship between relative resource richness and relative growth is not stable, depending on which abundance measure is used. Depending on whether a primary products-based resource abundance measure or mineral products-based resource abundance measure is used, the results are different. In the case of primary products resource measures (SXP and PXI70), the resource impact on growth is either not significant (SXP) or strongly positive (PXI70). However, if we use mineral resource measures, then in nearly all cases the effect appears negative and statistically significant.

Interestingly, if the mining share of GDP is used as a resource variable, then it also has a strong negative effect on relative growth over the 1960-1996 period – in line with Sala-i-Martin et al. (2004) - and the coefficient is significant at the 1 percent significance level. If we extend the time period to 1960-2003, however, the coefficient loses its statistical significance; it is significant only at 10 percent. These results are contradictory to what was obtained by Sala-i-Martin et al. (2004) who claim that the mining share of GDP has a positive effect on GDP growth. In this paper, we replicate their estimation and show that it is subject to omitted variable bias. In this respect, the matching methodology we employ aims to control for country-specific unobservables, which gives our estimation greater reliability. Indeed, the effect is opposite to what was claimed by Sala-i-Martin et al. (2004).

In all other cases, the effect appears statistically insignificant. This leads us to claim that the effect of resource richness on growth does not pass the time test. By changing time periods, the estimation results also change and become insignificant. Lederman and Maloney (2002) reached the same conclusion about the failure to pass the test of time.

We, thus, conclude that resource richness has no permanent effect on GDP growth over the long-term.

Furthermore, we look at time series evidence. Having identified the matched pairs, we analyze relative GDP per capita from the time-series perspective. The question we wish to answer is what the relative GDP per capita performance of a resource-rich country was with respect to a comparison country before and after it became resource rich. We identified 14 countries that show a significant increase of resource export shares in total merchandise exports over the available dataset during 1960-2003. A significant increase is defined so that in a particular year the difference between next year's export share and the previous year's export share is greater than 20%, and that this increase persists over the next 10 years.

The time-series evidence shows a significant increase in relative GDP during the first 10 years, on average, after the resource abundance increase. Afterwards, the relative GDP per capita growth is negative for a longer time; there is a boom for a short time followed by long period of bust. The length of the boom and bust periods vary depending on the country under consideration, though on average, the bust period is 20 years. Seemingly, after a long bust period, the relative GDP remains stable. This leads us to conclude that in the very long term, resource abundance has only a level effect on per capita GDP.

1.6. References

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1.7. Data

GR7003 Average GDP per capita growth (constant prices: Laspeyres) over the 1970-2003 period. Source: Heston, Summers and Aten (2006). Average growth is computed as:

$$\frac{1}{33}\sum_{i=1}^{33}[\frac{Y_{1970+i}}{Y_{1970+i-1}}\cdot 100-100].$$

MINING The fraction of GDP produced in the mining and quarrying sector. Data are for the year 1988 when possible, or the closest available year. Source: Hall and Jones (1999)

MINxx-yy Fuels exports plus ores and metals exports as a percentage of total merchandise exports, average over period 19xx-19yy. Source: World Development Indicators 2007, World Bank

SXP Share of exports of primary products in GNP in 1970. Primary products or natural resource exports are exports of “fuels” and “non-fuel primary products”. Non-fuel primary products correspond to SITC categories 0, 1, 2, 4, and 68. Fuels correspond to SITC category 3. These categories are from revision 1 of the SITC. Source: Sachs and Warner (1997)

PXI70 Primary export intensity in 1970. Ratio of primary exports to total merchandise exports in 1970. See SXP for the definition of primary exports. Source: Sachs and Warner (1997)

SNR The share of mineral production in GNP in 1971. $SNR=\frac{M71*1000}{GNPD71*POP70}$, where, M71 is the value of mineral production in 1971. This is calculated by Sachs and Warner (1997) from price and quantity data as: $M71_j=\sum_{j=1}^{23}p_i\cdot mq_{ij}$. The sum is over 23 minerals.

All other variables were taken from Sala-i-Martin et al (2004).

1.8. Tables

Table 1.1: 17 variables used for matching from Sala-i-Martin et al. (2004)

No	Variable name	Description and source
1	EAST	Dummy for East Asian countries
2	P60	Enrollment rate in primary education in 1960
3	IPRICE1	Average investment price level between 1960 and 1964 on purchasing power parity basis
4	GDPCH60L	Logarithm of GDP per capita in 1960
5	TROPICAR	Proportion of country's land area within geographical tropics
6	DENS65C	Coastal (within 100km of coastline) population per coastal area in 1965
7	MALFAL66	Index of malaria prevalence in 1966
8	LIFE060	Life expectancy in 1960
9	CONFUC	Fraction of population Confucian
10	SAFRICA	Dummy for Sub-Saharan African countries
11	LAAM	Dummy for Latin American countries
12	SPAIN	Dummy variable for former Spanish colonies
13	YRSOPEN	Number of years economy has been open between 1950-1964
14	MUSLIM00	Fraction of population Muslim in 1960
15	BUDDHA	Fraction of population Buddhist in 1960
16	AVELF	Average of five different indices of ethno-linguistic fractionalization, which is the probability of two random people in a country not speaking the same language
17	GOVSH61	Share of expenditures on government consumption to GDP in 1961

Table 1.2: Matched countries based on covariates in Table 1

"Treatment" country		Matched country		Distance measure
DZA	Algeria	TUN	Tunisia	0.0731
		BHR	Bahrain	0.0974
AGO	Angola	SLE	Sierra Leone	0.0254
		CIV	Cote d'Ivoire	0.0404
		LBR	Liberia	0.0670
		NGA	Nigeria	0.0715
		HVO	Burkina Faso	0.0767
		GNB	Guinea-Bissau	0.0783
		GHA	Ghana	0.0833
		KEN	Kenya	0.0871
		MLI	Mali	0.0973
ARG	Argentina	URY	Uruguay	0.0583
AUS	Australia	LUX	Luxembourg	0.0618
		FIN	Finland	0.0640
		DEU	Germany, West	0.0703
		AUT	Austria	0.0737
		ITA	Italy	0.0739
		DNK	Denmark	0.0748
		FRA	France	0.0765
		ISL	Iceland	0.0774
		IRL	Ireland	0.0823
		NLD	Netherlands	0.0834
		CHE	Switzerland	0.0835
		SWE	Sweden	0.0883
		ESP	Spain	0.0895
		BEL	Belgium	0.0917
		USA	United States	0.0922
		CAN	Canada	0.0954
AUT	Austria	DEU	Germany, West	0.0204
		FRA	France	0.0272
		FIN	Finland	0.0278
		ITA	Italy	0.0312
		SWE	Sweden	0.0464
		LUX	Luxembourg	0.0686
		BEL	Belgium	0.0851
BHS	Bahamas, The	GRD	Grenada	0.0004
		JAM	Jamaica	0.0059
		BRB	Barbados	0.0342
		VCT	St.Vincent & Grens.	0.0367
		BRA	Brazil	0.0795
		TTO	Trinidad & Tobago	0.0844
		GUY	Guyana	0.0928
BHR	Bahrain	MAR	Morocco	0.0920

Table 1.2 continued

BRB	Barbados	GRD	Grenada	0.0298
		VCT	St.Vincent & Grens.	0.0680
BEL	Belgium	LUX	Luxembourg	0.0441
		FIN	Finland	0.0737
		FRA	France	0.0741
		ITA	Italy	0.0748
		DEU	Germany, West	0.0806
BOL	Bolivia	PER	Peru	0.0812
		GTM	Guatemala	0.0972
BRA	Brazil	GRD	Grenada	0.0226
		VCT	St.Vincent & Grens.	0.0548
		DOM	Dominican Rep.	0.0990
HVO	Burkina Faso	ETH	Ethiopia	0.0717
		GNB	Guinea-Bissau	0.0814
CMR	Cameroon	UGA	Uganda	0.0496
		GHA	Ghana	0.0930
		CIV	Cote d'Ivoire	0.0992
CAN	Canada	USA	United States	0.0513
		CHE	Switzerland	0.0620
		FRA	France	0.0646
		ISL	Iceland	0.0685
		BEL	Belgium	0.0761
		LUX	Luxembourg	0.0769
		SWE	Sweden	0.0806
		FIN	Finland	0.0812
		DEU	Germany, West	0.0839
		AUT	Austria	0.0850
		DNK	Denmark	0.0869
		GBR	United Kingdom	0.0917
		ESP	Spain	0.0932
		NLD	Netherlands	0.0934
		ITA	Italy	0.0956
CAF	Central Afr. Rep.	TZA	Tanzania	0.0945
		BEN	Benin	0.0945
TCD	Chad	SDN	Sudan	0.0773
COL	Colombia	NIC	Nicaragua	0.0663
		HON	Honduras	0.0868
		SLV	El Salvador	0.0930
		MEX	Mexico	0.0967
CRI	Costa Rica	PAN	Panama	0.0549
		SLV	El Salvador	0.0722
CIV	Cote d'Ivoire	KEN	Kenya	0.0680
		GNB	Guinea-Bissau	0.0852
		HVO	Burkina Faso	0.0997

Table 1.2 continued

DNK	Denmark	DEU	Germany, West	0.0170
		AUT	Austria	0.0268
		FRA	France	0.0295
		SWE	Sweden	0.0328
		FIN	Finland	0.0408
		ITA	Italy	0.0424
		ISL	Iceland	0.0478
		IRL	Ireland	0.0587
		LUX	Luxembourg	0.0699
		ESP	Spain	0.0857
		BEL	Belgium	0.0880
DMA	Dominica	LCA	St.Lucia	0.0338
DOM	Dominican Rep.	GRD	Grenada	0.0044
		VCT	St.Vincent & Grens.	0.0775
ECU	Ecuador	PER	Peru	0.0872
		BOL	Bolivia	0.0912
SLV	El Salvador	PAN	Panama	0.0860
FJI	Fiji	SLB	Solomon Islands	0.0000
		WSM	Samoa	0.0000
		VUT	Vanuatu	0.0091
		TON	Tonga	0.0106
FIN	Finland	ITA	Italy	0.0256
		DEU	Germany, West	0.0292
		FRA	France	0.0385
		LUX	Luxembourg	0.0456
		SWE	Sweden	0.0634
FRA	France	DEU	Germany, West	0.0291
		SWE	Sweden	0.0346
		ITA	Italy	0.0476
		LUX	Luxembourg	0.0665
GAB	Gabon	CIV	Cote d'Ivoire	0.0540
		ZWE	Zimbabwe	0.0754
GMB	Gambia	SDN	Sudan	0.0857
DEU	Germany, West	ITA	Italy	0.0322
		SWE	Sweden	0.0443
		LUX	Luxembourg	0.0588
GHA	Ghana	UGA	Uganda	0.0829
GRC	Greece	IRL	Ireland	0.0494
		ESP	Spain	0.0551
		ITA	Italy	0.0597
		FIN	Finland	0.0667
		AUT	Austria	0.0693
		ISL	Iceland	0.0775
		FRA	France	0.0819
		DEU	Germany, West	0.0832
		DNK	Denmark	0.0895
		BEL	Belgium	0.0988

Table 1.2 continued

GRD	Grenada	VCT HTI	St.Vincent & Grens. Haiti	0.0004 0.0261
GIN	Guinea	SDN	Sudan	0.0692
GNB	Guinea-Bissau	KEN	Kenya	0.0785
GUY	Guyana	GRD VCT	Grenada St.Vincent & Grens.	0.0991 0.0992
HND	Honduras	SLV	El Salvador	0.0479
HUN	Hungary	YUG	Yugoslavia	0.0711
ISL	Iceland	FRA AUT DEU FIN ITA SWE IRL BEL LUX ESP	France Austria Germany, West Finland Italy Sweden Ireland Belgium Luxembourg Spain	0.0362 0.0398 0.0480 0.0484 0.0519 0.0544 0.0572 0.0665 0.0701 0.0782
IDN	Indonesia	WSM SLB	Samoa Solomon Islands	0.0107 0.0107
IRQ	Iraq	DZA TUN	Algeria Tunisia	0.0746 0.0965
IRL	Ireland	AUT FIN ITA FRA DEU ESP SWE LUX BEL NZL	Austria Finland Italy France Germany, West Spain Sweden Luxembourg Belgium New Zealand	0.0411 0.0417 0.0425 0.0531 0.0553 0.0542 0.0755 0.0818 0.0863 0.0956
ITA	Italy	LUX SWE	Luxembourg Sweden	0.0591 0.0711
JAM	Jamaica	GRD VCT	Grenada St.Vincent & Grens.	0.0051 0.0330
LBR	Liberia	SLE TGO GNB TZA KEN MLI CMR CIV HVO BEN UGA	Sierra Leone Togo Guinea-Bissau Tanzania Kenya Mali Cameroon Cote d'Ivoire Burkina Faso Benin Uganda	0.0633 0.0695 0.0696 0.0764 0.0782 0.0795 0.0832 0.0866 0.0873 0.0914 0.0929

Table 1.2 continued

LUX	Luxembourg	SWE	Sweden	0.0899
MDG	Madagascar	RWA	Rwanda	0.0878
MLI	Mali	GNB	Guinea-Bissau	0.0587
		HVO	Burkina Faso	0.0802
		ETH	Ethiopia	0.0881
		TZA	Tanzania	0.0945
		SDN	Sudan	0.0988
MLT	Malta	HUN	Hungary	0.0952
		POL	Poland	0.0971
MOZ	Mozambique	SLE	Sierra Leone	0.0637
		BEN	Benin	0.0805
		TCD	Chad	0.0962
		UGA	Uganda	0.0967
NAM	Namibia	SYC	Seychelles	0.0289
		MDG	Madagascar	0.0535
		MOZ	Mozambique	0.0586
		CPV	Cape Verde	0.0625
		ETH	Ethiopia	0.0743
		TZA	Tanzania	0.0766
		KEN	Kenya	0.0773
		HVO	Burkina Faso	0.0778
		BDI	Burundi	0.0778
		CAF	Central Afr. Rep.	0.0778
		RWA	Rwanda	0.0778
		ZWE	Zimbabwe	0.0778
		GAB	Gabon	0.0778
		SOM	Somalia	0.0778
		AGO	Angola	0.0778
		COG	Congo	0.0778
		LBR	Liberia	0.0779
		ZAR	Zaire	0.0781
		CIV	Cote d'Ivoire	0.0781
		SLE	Sierra Leone	0.0783
		SEN	Senegal	0.0785
		ZMB	Zambia	0.0786
		NER	Niger	0.0793
		TGO	Togo	0.0795
		TCD	Chad	0.0818
		MLI	Mali	0.0822
		NGA	Nigeria	0.0831
		SDN	Sudan	0.0854
		BEN	Benin	0.0868
		UGA	Uganda	0.0871
		CMR	Cameroon	0.0905
		GNB	Guinea-Bissau	0.0936
		GIN	Guinea	0.0970

Table 1.2 continued

NLD	Netherlands	DNK	Denmark	0.0352
		DEU	Germany, West	0.0363
		ITA	Italy	0.0407
		ISL	Iceland	0.0438
		FRA	France	0.0459
		AUT	Austria	0.0465
		FIN	Finland	0.0523
		GBR	United Kingdom	0.0535
		SWE	Sweden	0.0585
		LUX	Luxembourg	0.0615
		IRL	Ireland	0.0664
		BEL	Belgium	0.0695
		USA	United States	0.0720
		ESP	Spain	0.0805
		GRC	Greece	0.0889
		PRT	Portugal	0.0969
		CHE	Switzerland	0.0988
NIC	Nicaragua	HON	Honduras	0.0650
		GTM	Guatemala	0.0868
		SLV	El Salvador	0.0885
		PER	Peru	0.0946
		MEX	Mexico	0.0999
NER	Niger	MLI	Mali	0.0711
		SDN	Sudan	0.0840
		SEN	Senegal	0.0844
		SLE	Sierra Leone	0.0964
		TZA	Tanzania	0.0966
NGA	Nigeria	SLE	Sierra Leone	0.0671
		CIV	Cote d'Ivoire	0.0731
		GNB	Guinea-Bissau	0.0773
		GHA	Ghana	0.0841
		LBR	Liberia	0.0849
		CMR	Cameroon	0.0907
		MLI	Mali	0.0920
		ETH	Ethiopia	0.0920
		HVO	Burkina Faso	0.0921
		KEN	Kenya	0.0924
		GIN	Guinea	0.0948
		UGA	Uganda	0.0963
PNG	Papua New Guinea	WSM	Samoa	0.0000
		SLB	Solomon Islands	0.0000
		TON	Tonga	0.0000
		VUT	Vanuatu	0.0000

Table 1.2 continued

PER	Peru	HND	Honduras	0.0870
		SLV	El Salvador	0.0873
		GTM	Guatemala	0.0894
PHL	Philippines	WSM	Samoa	0.0215
		SLB	Solomon Islands	0.0215
		VUT	Vanuatu	0.0234
		TON	Tonga	0.0273
POL	Poland	HUN	Hungary	0.0149
		NZL	New Zealand	0.0394
		YUG	Yugoslavia	0.0735
PRT	Portugal	GRC	Greece	0.0389
		IRL	Ireland	0.0581
		ITA	Italy	0.0662
		ESP	Spain	0.0709
		AUT	Austria	0.0753
		FIN	Finland	0.0769
		DEU	Germany, West	0.0897
		FRA	France	0.0926
		ISL	Iceland	0.0941
		DNK	Denmark	0.0981
RWA	Rwanda	SYC	Seychelles	0.0957
WSM	Samoa	SLB	Solomon Islands	0.0000
		TON	Tonga	0.0000
		VUT	Vanuatu	0.0000
SEN	Senegal	SDN	Sudan	0.0754
SLE	Sierra Leone	GNB	Guinea-Bissau	0.0442
		CIV	Cote d'Ivoire	0.0525
		CAF	Central Afr. Rep.	0.0542
		TZA	Tanzania	0.0566
		BEN	Benin	0.0590
		TCD	Chad	0.0734
		MLI	Mali	0.0737
		HVO	Burkina Faso	0.0758
		ETH	Ethiopia	0.0886
		KEN	Kenya	0.0966
		UGA	Uganda	0.0997
SLB	Solomon Islands	TON	Tonga	0.0000
		VUT	Vanuatu	0.0000
ESP	Spain	FIN	Finland	0.0530
		ITA	Italy	0.0556
		BEL	Belgium	0.0635
		LUX	Luxembourg	0.0678
		AUT	Austria	0.0717
		FRA	France	0.0737
		DEU	Germany, West	0.0766
LCA	St.Lucia	SUR	Suriname	0.0744

Table 1.2 continued

CHE	Switzerland	LUX	Luxembourg	0.0496
		USA	United States	0.0724
		FIN	Finland	0.0799
		BEL	Belgium	0.0805
		FRA	France	0.0889
		ISL	Iceland	0.0891
		DEU	Germany, West	0.0892
		ESP	Spain	0.0904
		ITA	Italy	0.0926
		DNK	Denmark	0.0967
		AUT	Austria	0.0969
SYR	Syria	TUR	Turkey	0.0437
TGO	Togo	TZA	Tanzania	0.0543
		SLE	Sierra Leone	0.0701
		MWI	Malawi	0.0954
		GNB	Guinea-Bissau	0.0977
		CAF	Central Afr. Rep.	0.0982
TON	Tonga	VUT	Vanuatu	0.0000
TTO	Trinidad & Tob.	GRD	Grenada	0.0948
TUN	Tunisia	MAR	Morocco	0.0963
		TUR	Turkey	0.0969
ARE	United Arab Em.	BHR	Bahrain	0.0367
		SAU	Saudi Arabia	0.0730
		IRN	Iran, I.R. of	0.0859
		DZA	Algeria	0.0869
		KWT	Kuwait	0.0871
GBR	United Kingdom	SWE	Sweden	0.0339
		FRA	France	0.0410
		DNK	Denmark	0.0422
		DEU	Germany, West	0.0490
		AUT	Austria	0.0534
		USA	United States	0.0633
		FIN	Finland	0.0685
		ISL	Iceland	0.0704
		ITA	Italy	0.0716
		IRL	Ireland	0.0781
		BEL	Belgium	0.0960
		LUX	Luxembourg	0.0963
USA	United States	FRA	France	0.0506
		SWE	Sweden	0.0558
		DEU	Germany, West	0.0583
		DNK	Denmark	0.0604
		AUT	Austria	0.0680
		FIN	Finland	0.0704
		ISL	Iceland	0.0707
		LUX	Luxembourg	0.0738
		ITA	Italy	0.0815
		BEL	Belgium	0.0882
ZMB	Zambia	LBR	Liberia	0.0655
		KEN	Kenya	0.0659
		SLE	Sierra Leone	0.0770
		TGO	Togo	0.0875
		GNB	Guinea-Bissau	0.0889
ZWE	Zimbabwe	CIV	Cote d'Ivoire	0.0673

Table 1.3: The impact coefficients of relative resource abundance on relative growth as in equation (1.4) within distance 0.1, OLS estimation, with the bootstrap estimates of the standard errors (replications=1000)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	SM	SW	SW	PWT	PWT	PWT	PWT
	regression results	D_GR6096	D_GEA7090	D_GEA8090	D_GR6003	D_GR7003	D_GR8003	D_GR9003
(1)	D_MINING	-0.067	-	-	-0.020	-	-	-0.046
	Bootstr. Std. errs.	0.011***			0.010**			0.020**
	R-squared	0.16			0.02			0.02
	# of observations	301			230			309
(2)	D_SXP	-	-0.0009	-	-	-0.001	-	-
	Bootstr. Std. errs.		0.011			0.014		
	R-squared		0.00			0.00		
	# of observations		232			261		
(3)	D_SXP80	-	-	-0.025	-	-	-0.026	-
	Bootstr. Std. errs.			0.008***			0.009***	
	R-squared			0.04			0.06	
	# of observations			223			251	
(4)	D_SNR	-	-0.035	-	-	-0.043	-	-
	Bootstr. Std. errs.		0.010***			0.006***		
	R-squared		0.09			0.29		
	# of observations		262			296		
(5)	D_PXI70	-	0.009	-	-	0.013	-	-
	Bootstr. Std. errs.		0.003***			0.003***		
	R-squared		0.04			0.05		
	# of observations		235			275		
(6)	D_MIN66-70	-	-0.000	-	-	-0.017	-	-
	Bootstr. Std. errs.		0.006			0.005***		
	R-squared		0.00			0.07		
	# of observations		233			252		
(7)	D_MIN76-80	-	-	-0.024	-	-	-0.018	-
	Bootstr. Std. errs.			0.006***			0.005***	
	R-squared			0.15			0.09	
	# of observations			228			264	

Table 1.4: The impact coefficients of relative resource abundance on relative growth as in equation (1.4), WLS estimation: the weights are the inverses of the distance measure.

	WLS regression results	(1) SM D_GR6096	(2) SW D_GEA7090	(3) SW D_GEA8090	(4) PWT D_GR6003	(6) PWT D_GR7003	(7) PWT D_GR8003	(8) PWT D_GR9003
(1)	D_MINING	-0.062	-	-	-0.016	-	-	-0.055
	Std. errs.	0.009***			0.011			0.019***
	R-squared	0.14			0.00			0.02
	# of observations	301			230			309
(2)	D_SXP	-	-0.001	-	-	0.005	-	-
	Std. errs.		0.008			0.007		
	R-squared		0.00			0.00		
	# of observations		232			261		
(3)	D_SXP80	-	-	-0.017	-	-	-0.018	-
	Std. errs.			0.007**			0.006***	
	R-squared			0.02			0.03	
	# of observations			223			252	
(4)	D_PXI70	-	0.008	-	-	0.013	-	-
	Std. errs.		0.003***			0.003***		
	R-squared		0.04			0.07		
	# of observations		235			275		
(5)	D_SNR	-	-0.032	-	-	-0.043	-	-
	Std. errs.		0.006***			0.004***		
	R-squared		0.09			0.28		
	# of observations		262			296		
(6)	D_MIN66-70	-	0.003	-	-	-0.015	-	-
	Std. errs.		(0.57)			0.004***		
	R-squared		0.00			0.05		
	# of observations		233			252		
(7)	D_MIN76-80	-	-	-0.020	-	-	-0.020	-
	Std. errs.			0.004***			0.004***	
	R-squared			0.11			0.11	
	# of observations			228			264	

Table 1.5: The impact coefficients of relative resource abundance on relative growth as in equation (1.4) for unique matches, OLS estimation

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	SM	SW	SW	PWT	PWT	PWT	PWT
	regression results	D_GR6096	D_GEA7090	D_GEA8090	D_GR6003	D_GR7003	D_GR8003	D_GR9003
(1)	D_MINING	-0.084	-	-	-0.045	-	-	-0.050
	Std. errs.	0.024***			0.033			0.039
	R-squared	0.17			0.05			0.69
	# of observations	59			41			309
(2)	D_SXP	-	-0.042	-	-	0.043	-	-
	Std. errs.		0.028			0.023*		
	R-squared		0.06			0.06		
	# of observations		41			51		
(3)	D_SXP80	-	-	-0.040	-	-	-0.031	-
	Std. errs.			0.030			0.017*	
	R-squared			0.05			0.06	
	# of observations			38			48	
(4)	D_SNR	-	-0.015	-	-	-0.043	-	-
	Std. errs.		0.012			0.011***		
	R-squared		0.04			0.20		
	# of observations		48			60		
(5)	D_PXI70	-	0.003	-	-	0.018	-	-
	Std. errs.		0.010			0.012		
	R-squared		0.00			0.04		
	# of observations		42			59		
(6)	D_MIN66-70	-	-0.004	-	-	-0.023	-	-
	Std. errs.		0.017			0.018		
	R-squared		0.00			0.05		
	# of observations		32			35		
(7)	D_MIN76-80	-	-	-0.019	-	-	-0.021	-
	Std. errs.			0.009**			0.007***	
	R-squared			0.13			0.14	
	# of observations			38			53	

Table 1.6: The impact coefficients of relative resource abundance on relative growth as in equation (1.4) within distance 0.05, OLS estimation, with the bootstrap estimates of the standard errors (replications=1000)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
		D_GR6096	D_GEA7090	D_GEA8090	D_GR6003	D_GR7003	D_GR8003	D_GR9003
(1)	D_MINING	-0.047	-	-	0.033	-	-	0.017
	Bootstr. Std. errs.	0.034			0.030			0.067
	R-squared	0.13			0.03			0.00
	# of observations	58			45			65
	OECD pairs	52			42			56
(2)	D_SXP	-	0.024	-	-	0.048	-	-
	Bootstr. Std. errs.		0.013*			0.016		
	R-squared		0.07			0.26		
	# of observations		52			53		
	OECD pairs		49			49		
(3)	D_SXP80	-	-	0.003	-	-	0.028	-
	Bootstr. Std. errs.			0.010			0.010***	
	R-squared			0.00			0.15	
	# of observations			53			54	
	OECD pairs			50			50	
(4)	D_SNR	-	-0.045	-	-	-0.008	-	-
	Bootstr. Std. errs.		0.065			0.122		
	R-squared		0.11			0.00		
	# of observations		56			57		
	OECD pairs		53			52		
(5)	D_PXI70	-	0.008	-	-	0.010	-	-
	Bootstr. Std. errs.		0.004*			0.004**		
	R-squared		0.06			0.08		
	# of observations		53			59		
	OECD pairs		50			52		
(6)	D_MIN66-70	-	0.042	-	-	0.037	-	-
	Bootstr. Std. errs.		0.018**			0.019**		
	R-squared		0.09			0.07		
	# of observations		51			51		
	OECD pairs		50			50		
(7)	D_MIN76-80	-	-	-0.010	-	-	-0.013	-
	Bootstr. Std. errs.			0.012			0.010	
	R-squared			0.03			0.04	
	# of observations			53			59	
	OECD pairs			50			50	

Table 1.7: Replication of Sala-i-Martin et al (2004) results

Dependent variable: GR6096	OLS regression coefficients and t-stats	Impact coefficient in Sala-i-Martin et al (2004)
MINING	0.038446 (2.70)	0.038823
EAST	0.007611 (1.25)	0.021805
P60	0.01851 (2.78)	0.026852
IPRICE1	-0.000077 (-3.66)	-0.000084
GDPCH60L	-0.010977 (-4.75)	-0.008538
TROPICAR	-0.007121 (-1.52)	-0.014757
DENS65C	0.000004 (1.69)	0.000009
MALFAL66	-0.001272 (-0.24)	-0.015702
LIFE060	0.000532 (2.16)	0.000808
CONFUC	0.034218 (1.90)	0.054429
SAFRICA	-0.006033 (-1.15)	-0.014706
LAAM	-0.001916 (-0.29)	-0.012758
SPAIN	-0.004475 (-0.83)	-0.010720
YRSOPEN	0.005226 (1.04)	0.012209
MUSLIM00	0.007401 (1.65)	0.012629
BUDDHA	0.012106 (1.44)	0.021667
AVELF	-0.003050 (-0.60)	-0.011281
GOVSH61	-0.021675 (-1.26)	-0.044171
R-squared	0.8044	-
# of countries	96	96

Table 1.8: Time-series comparison of per capita GDP for matched countries before and after a break date

"Treatment" country	Matched Countries	Break year	Relative GDP performance
Angola	Sierra Leone, Cote d'Ivoire, Liberia, Nigeria, Burkina Faso, Guinea-Bissau, Ghana, Kenya and Mali	1973	For Angola, there is no per capita GDP data available in PWT
Cameroon	Uganda, Namibia, Nigeria, Ghana and Cote d'Ivoire	1978	refer to Figure 1.3 and Figure 1.4
Congo	Namibia and Benin	1972	Figure 1.5 and Figure 1.6
Ecuador	Peru, Bolivia and El Salvador	1972	Figure 1.7 and Figure 8
Egypt	United Arab Emirates	1978	Figure 1.9
Mauritania	no matches identified within defined distance	1962	not available
Mexico	Colombia and Nicaragua	1980	Figure 1.10 and Figure 1.11
Morocco	Bahrain and Tunisia	1974	Figure 1.12 and Figure 1.13
Niger	Mali, Namibia, Sudan, Senegal, Sierra Leone and Tanzania	1973	Figure 1.14 and Figure 1.15
Nigeria	Cote d'Ivoire, Guinea-Bissau, Ghana, Mali, Ethiopia, Burkina Faso, Kenya, Guinea and Uganda	1968	Figure 1.16 and Figure 1.17
Norway	Iceland, Austria, Finland, France, Italy, Sweden, Ireland, Sweden, Netherlands, Luxembourg, United Kingdom, United States of America, Spain, Greece, Belgium, Switzerland and Portugal	1978	Figure 1.18 and Figure 1.19
Papua New Guinea	Western Samoa, Solomon Islands, Tonga and Vanuatu	1972	No GDP per capita data is available for matched countries in PWT
Senegal	Sudan	1980	Figure 1.20
Togo	Tanzania, Zambia, Malawi and Guinea-Bissau	1962	Figure 1.21 and Figure 1.22

1.9. Figures

Figure 1.1: Resource-based growth and resource abundance

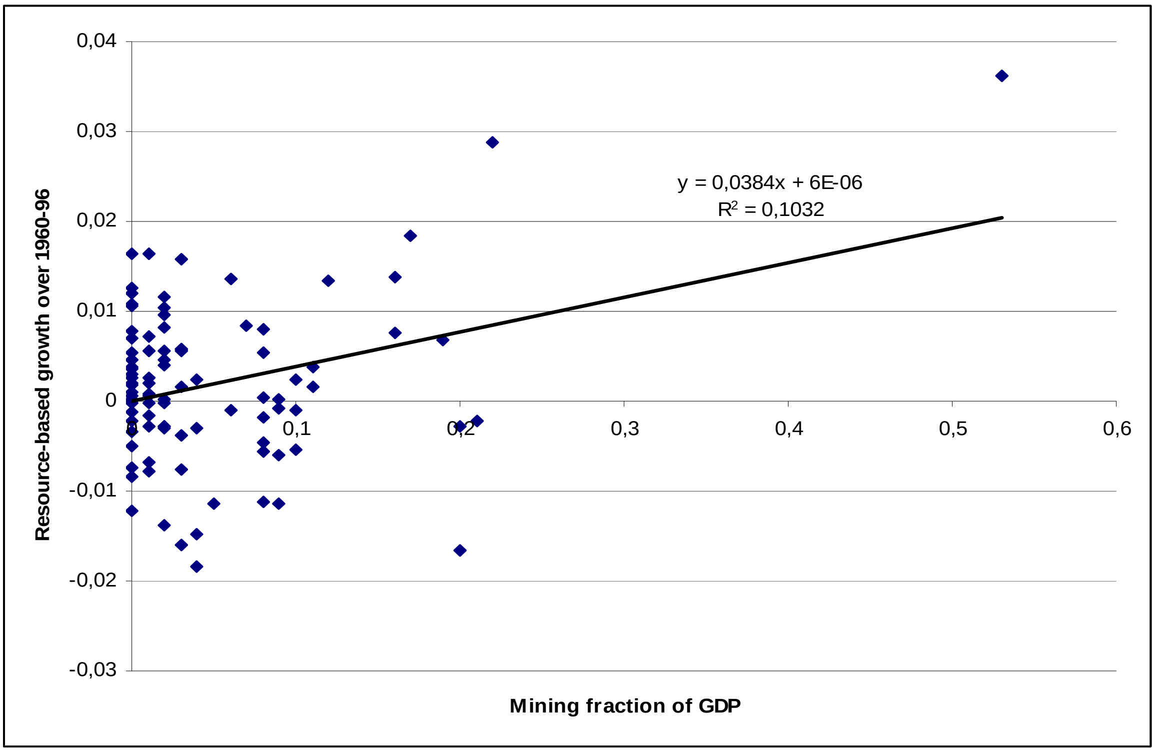


Figure 1.2: The relative resource richness and relative resource-based growth

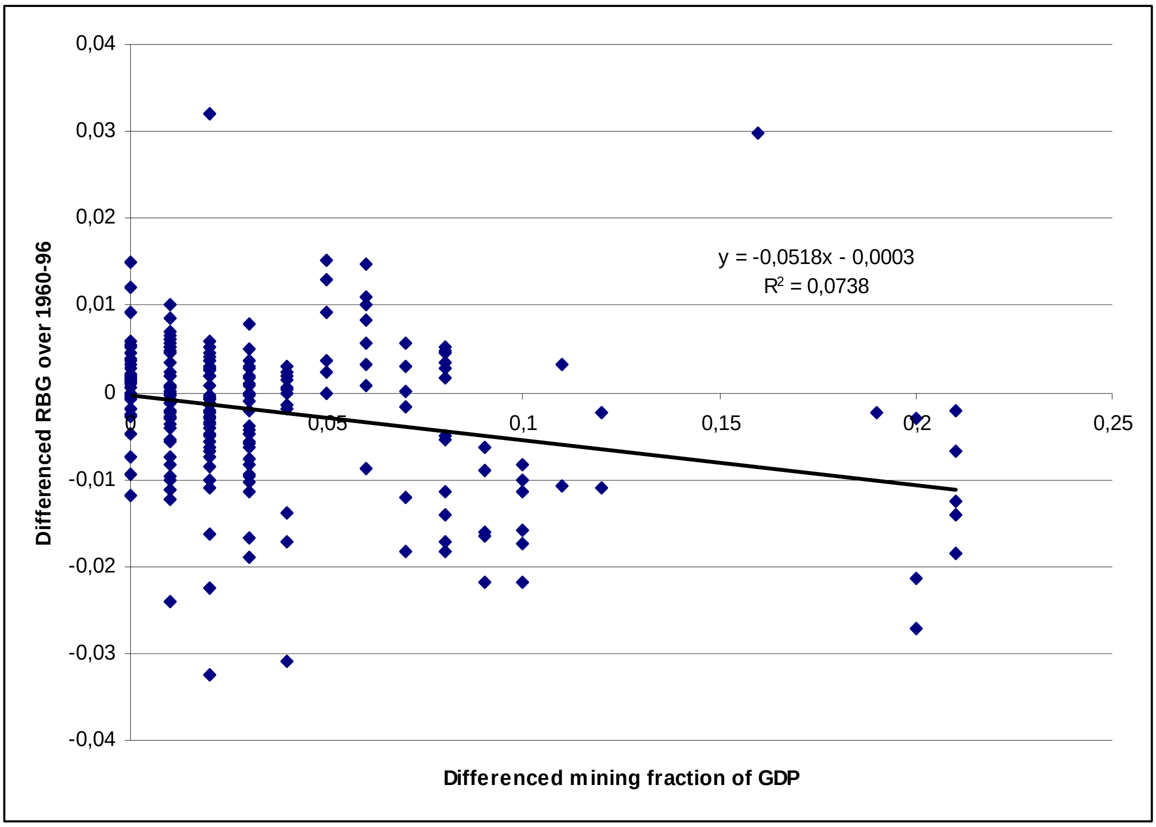


Figure 1.3: Cameroon as compared to Uganda, Namibia, Nigeria, Ghana and Cote d'Ivoire

Relative real GDP per capita ($ in 2000 Constant Prices: Lasp.) 1978=100

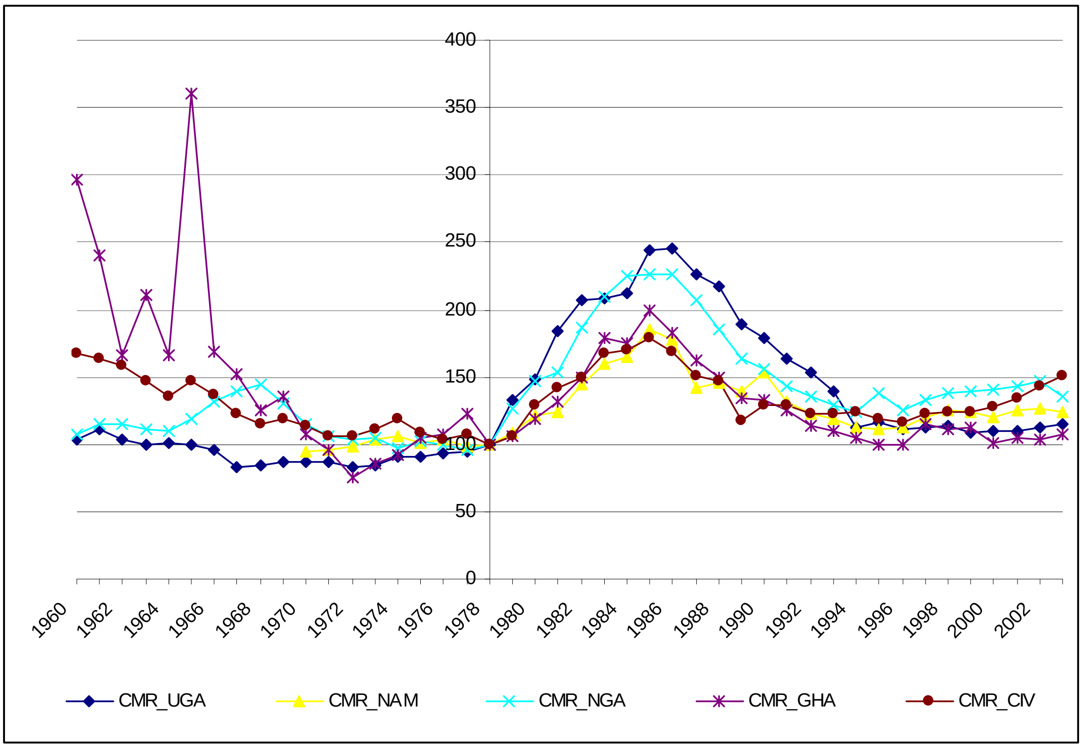


Figure 1.4: Cameroon as compared to the average of Uganda, Namibia, Nigeria, Ghana and Cote d'Ivoire Relative real GDP per capita ($ in 2000 Constant Prices: Lasp.) 1978=100

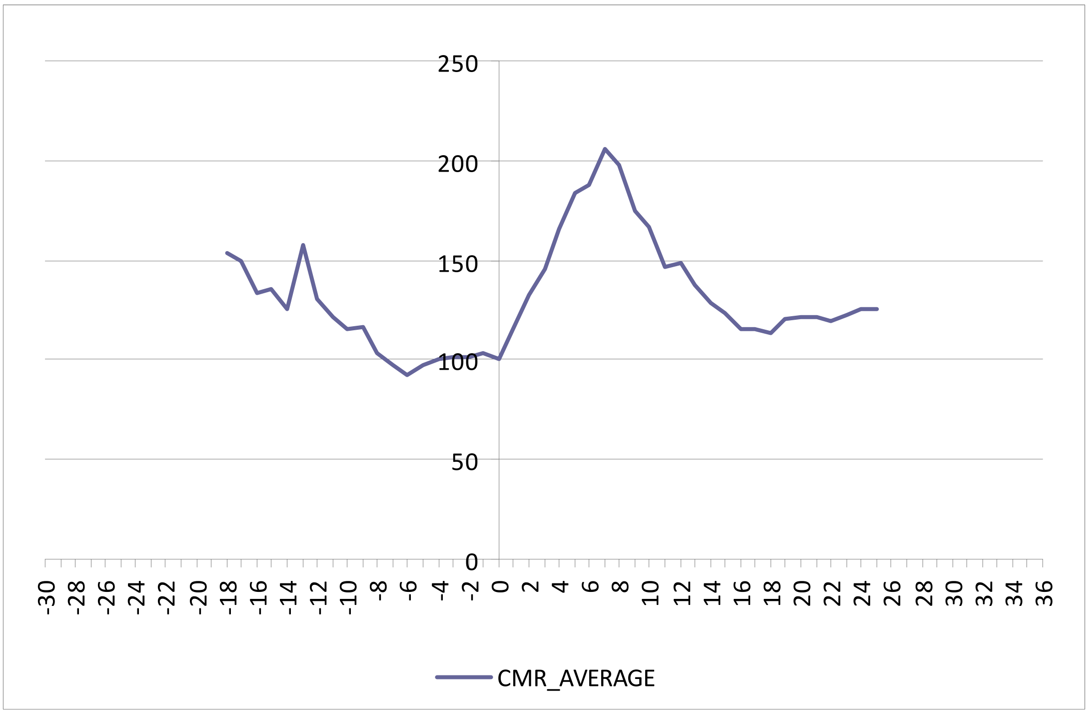


Figure 1.5: The Republic of Congo as compared to Namibia and Benin, 1962=100

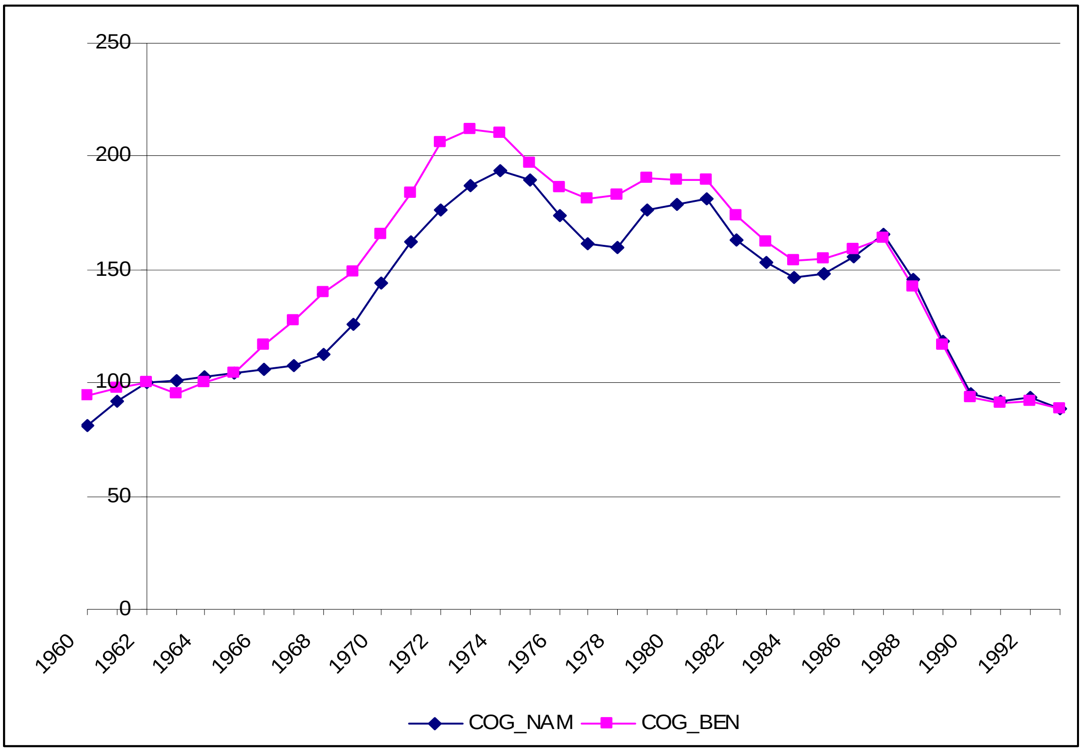


Figure 1.6: The Republic of Congo as compared to the average of Namibia and Benin, 1962=100

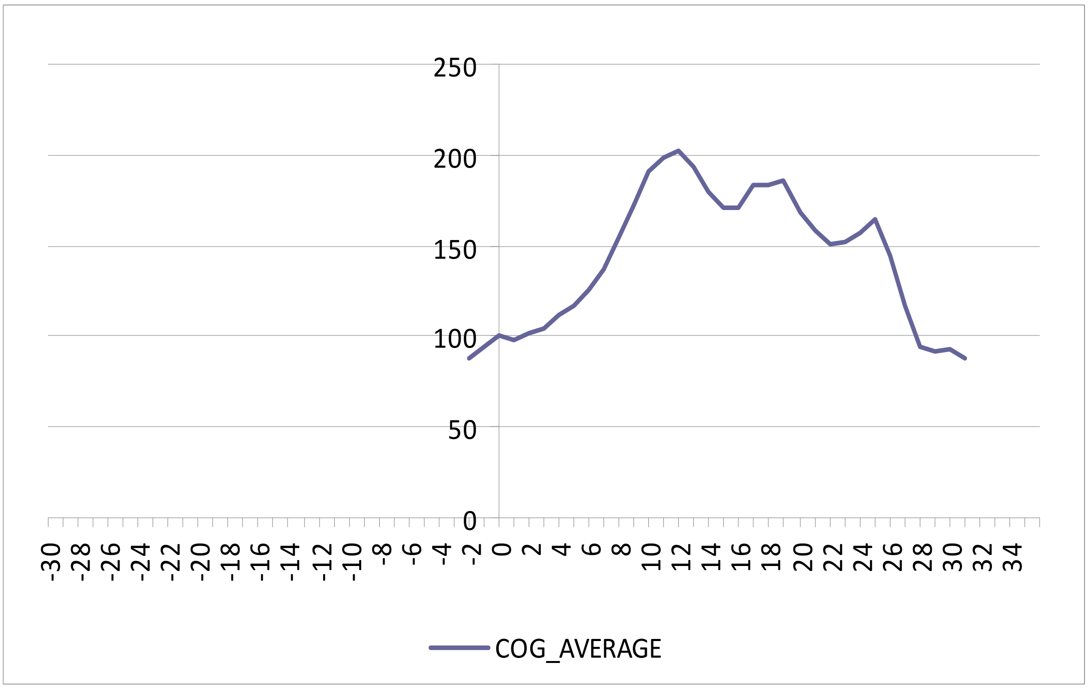


Figure 1.7: Ecuador as compared to Peru, Bolivia and El Salvador, 1972=100

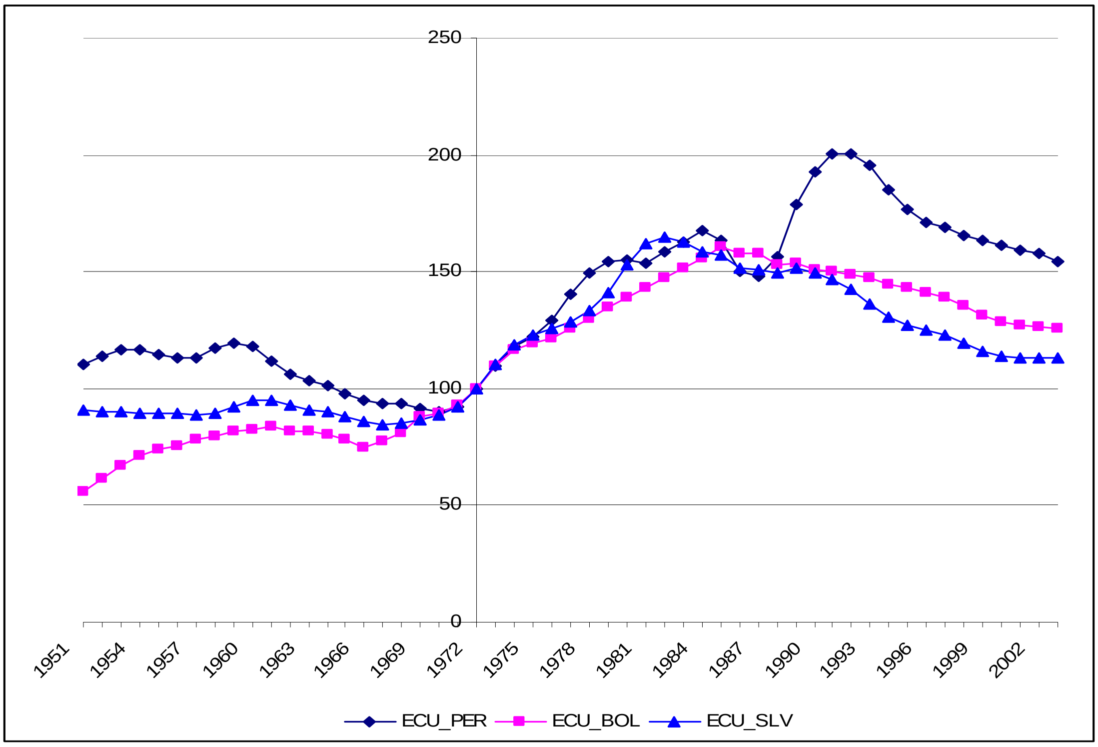


Figure 1.8: Ecuador as compared to the average of Peru, Bolivia and El Salvador, 1972=100

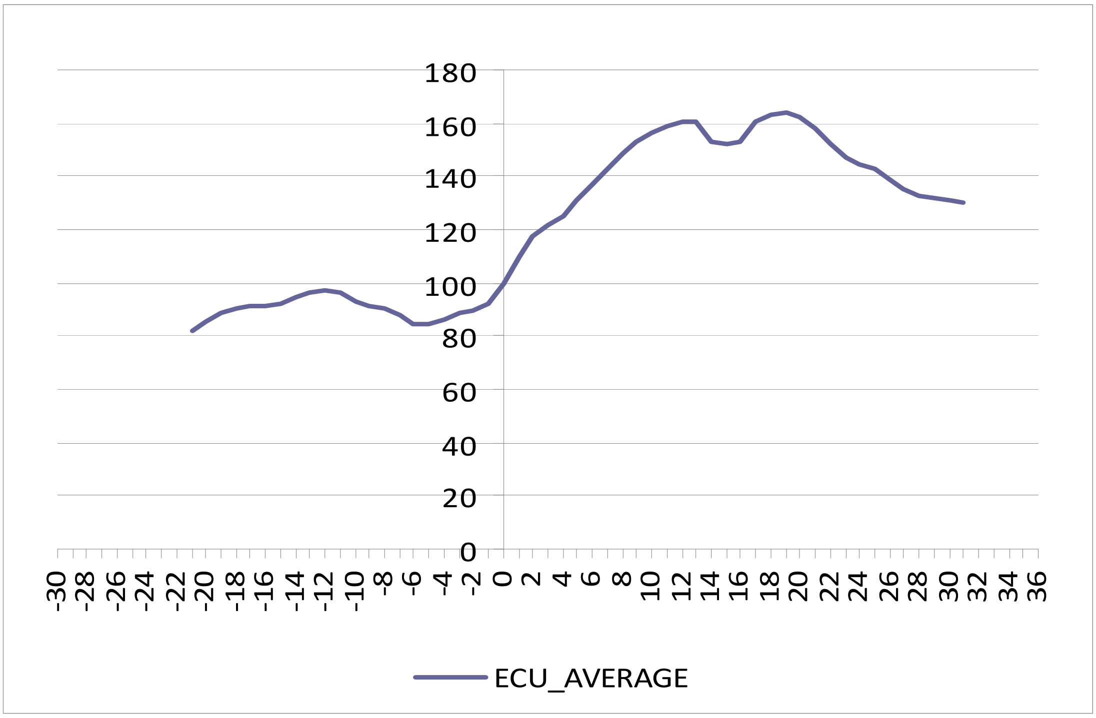


Figure 1.9: Egypt as compared to United Arab Emirates, 1978=100

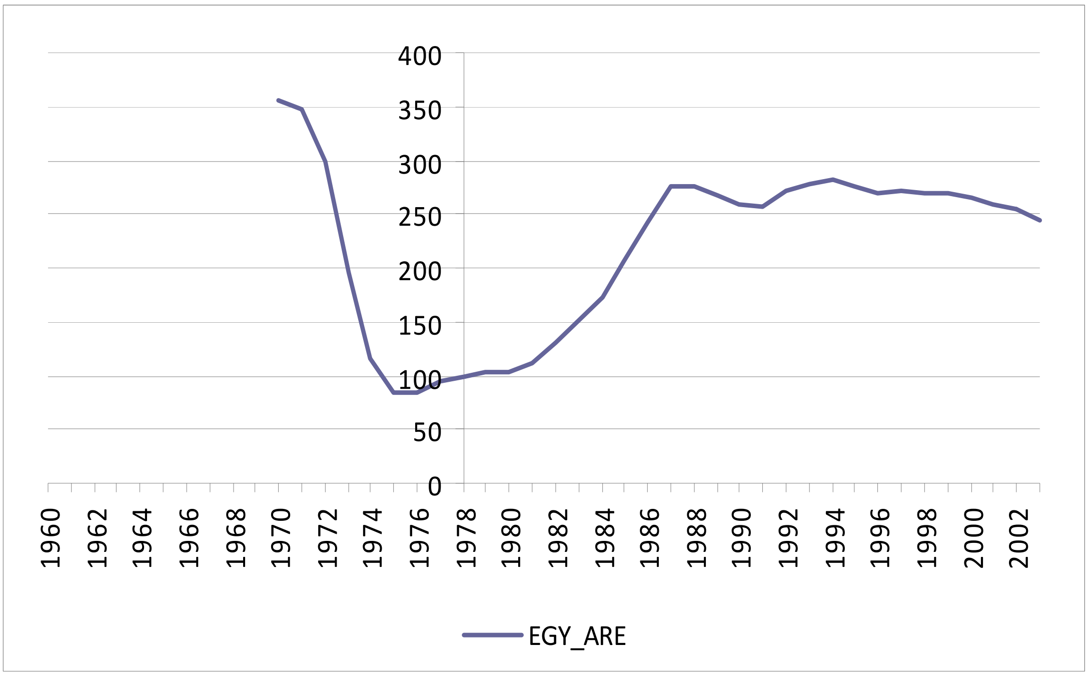


Figure 1.10: Mexico as compared to Colombia and Nicaragua, 1980=100

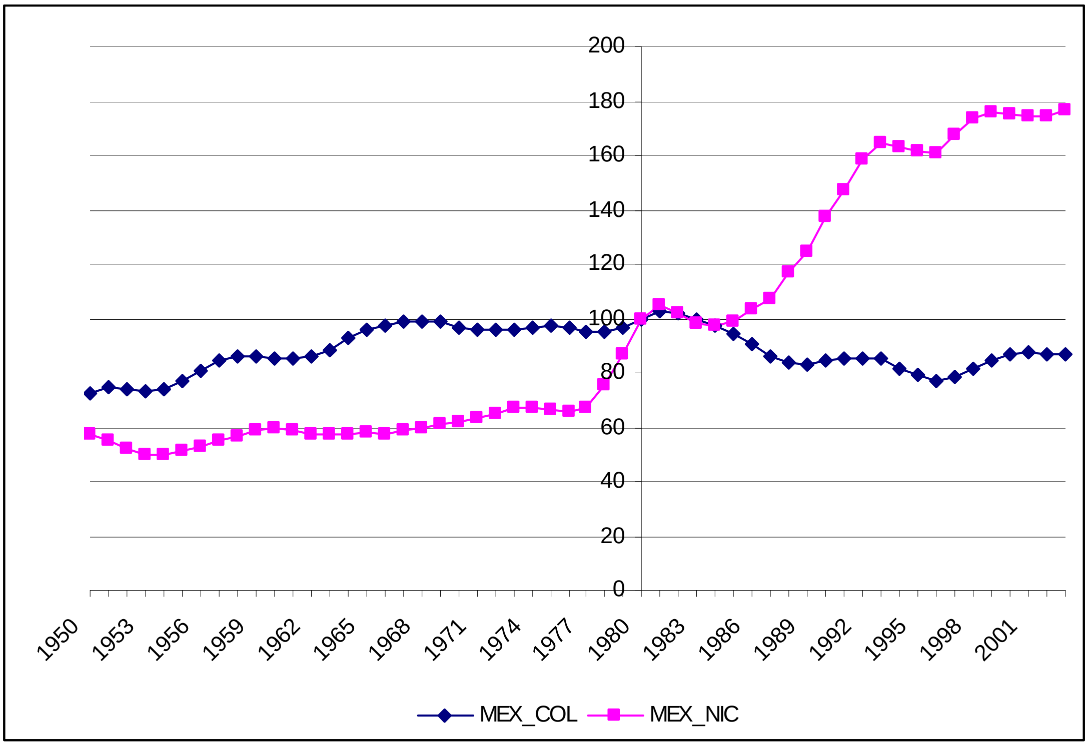


Figure 1.11: Mexico as compared to the average of Colombia and Nicaragua, 1980=100

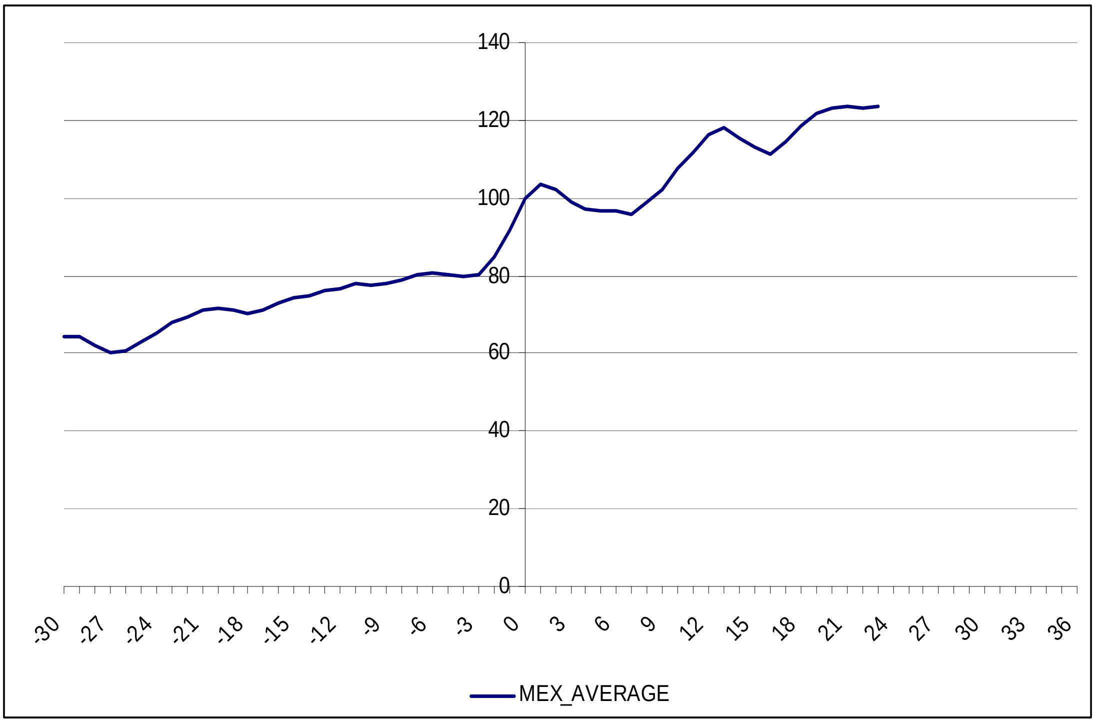


Figure 1.12: Morocco as compared to Bahrain and Tunisia, 1974=100

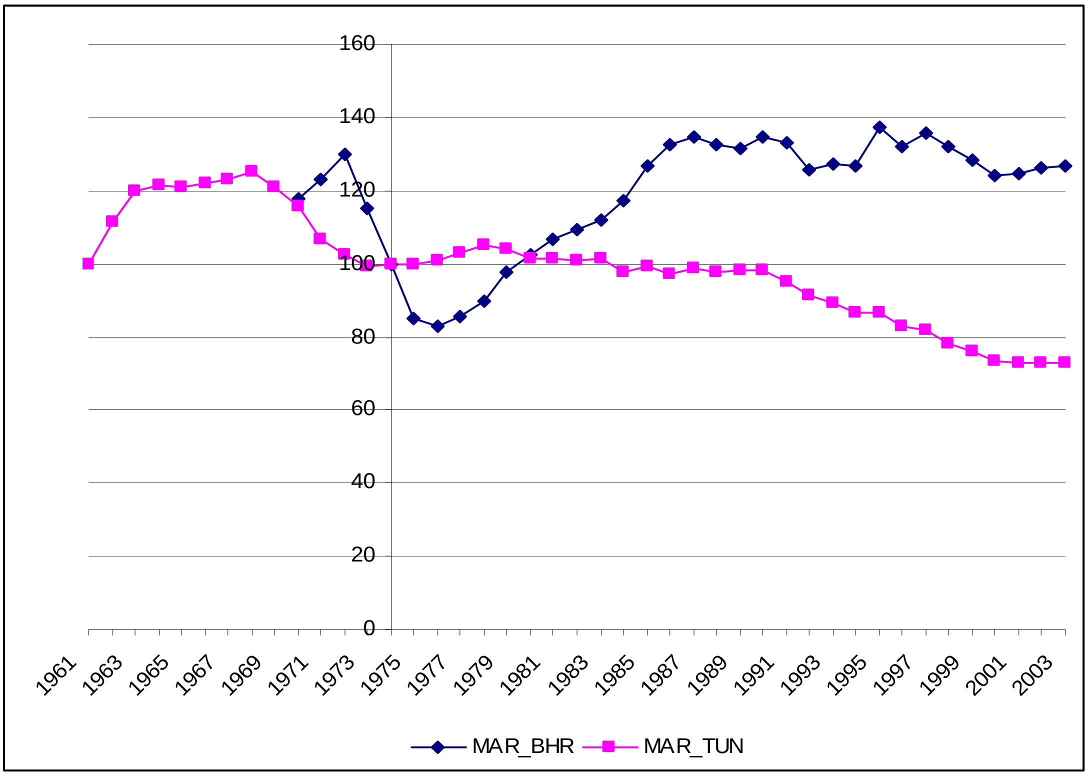


Figure 1.13: Morocco as compared to the average of Bahrain and Tunisia, 1974=100

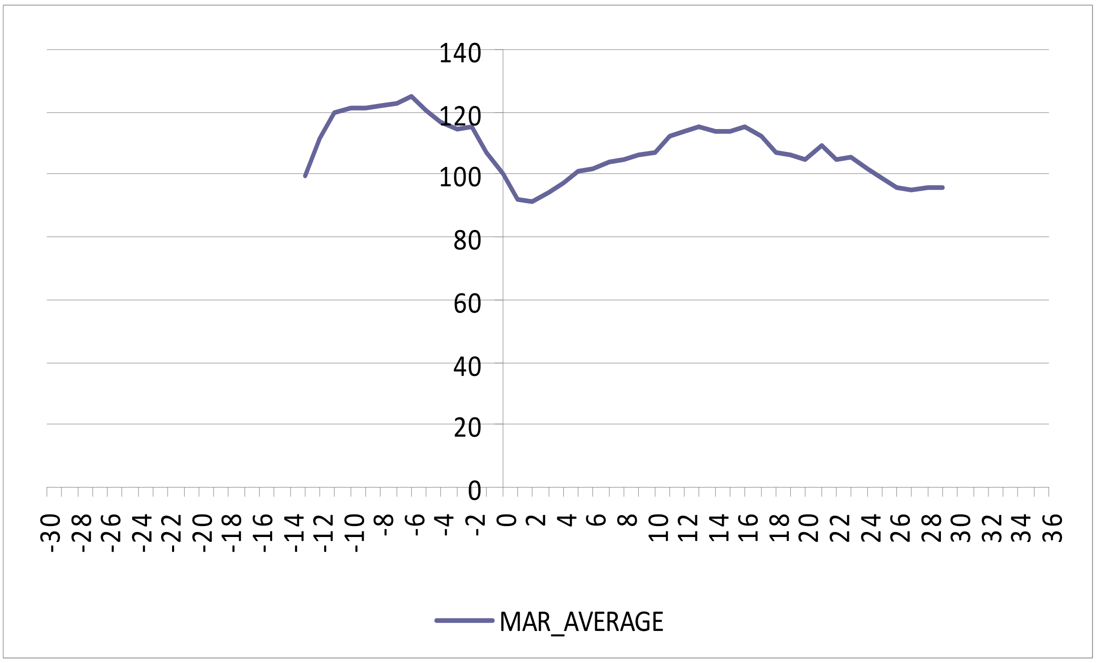


Figure 1.14: Niger as compared to Mali, Namibia, Sudan, Senegal, Sierra Leone and Tanzania, 1973=100

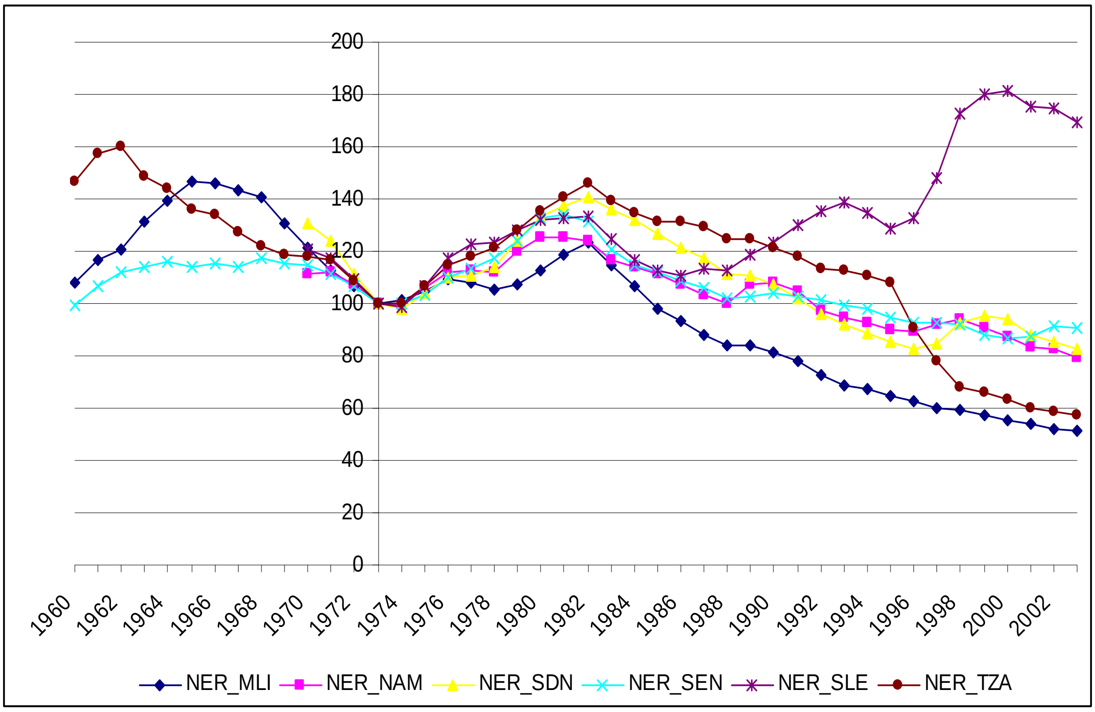


Figure 1.15: Niger as compared to the average of Mali, Namibia, Sudan, Senegal, Sierra Leone and Tanzania, 1973=100

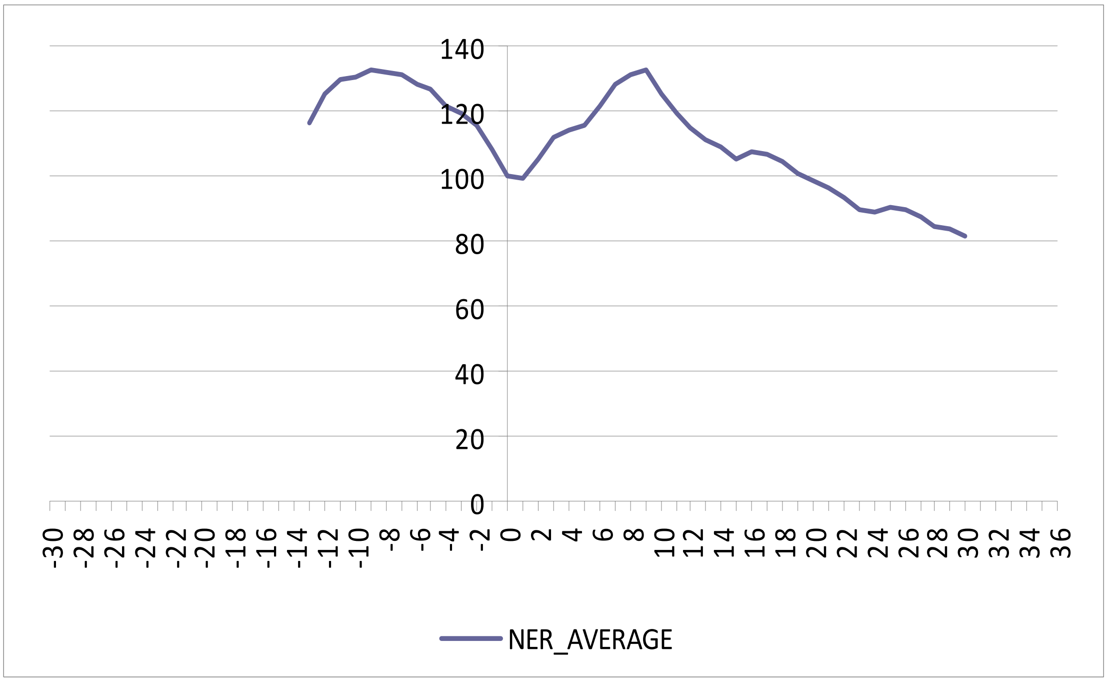


Figure 1.16: Nigeria as compared to Cote d'Ivoire, Guinea-Bissau, Ghana, Mali, Ethiopia, Burkina Faso, Kenya, Guinea and Uganda, 1968=100

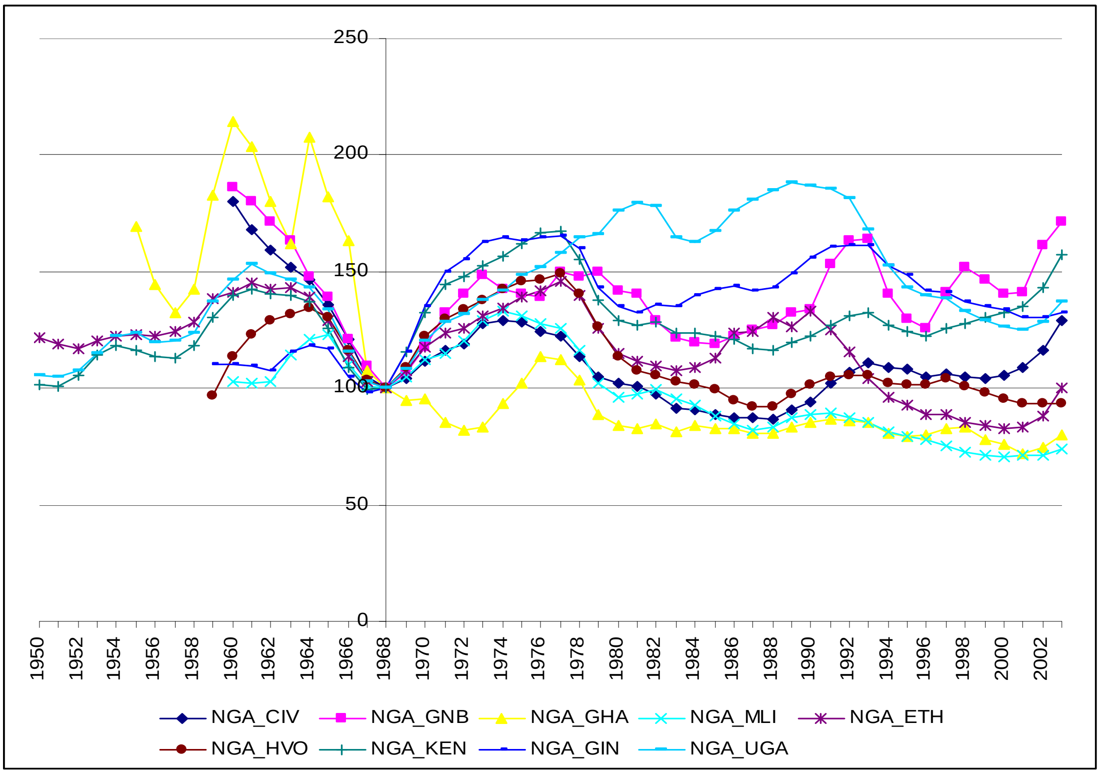


Figure 1.17: Nigeria as compared to the average of Cote d'Ivoire, Guinea-Bissau, Ghana, Mali, Ethiopia, Burkina, Faso, Kenya, Guinea and Uganda, 1968=100

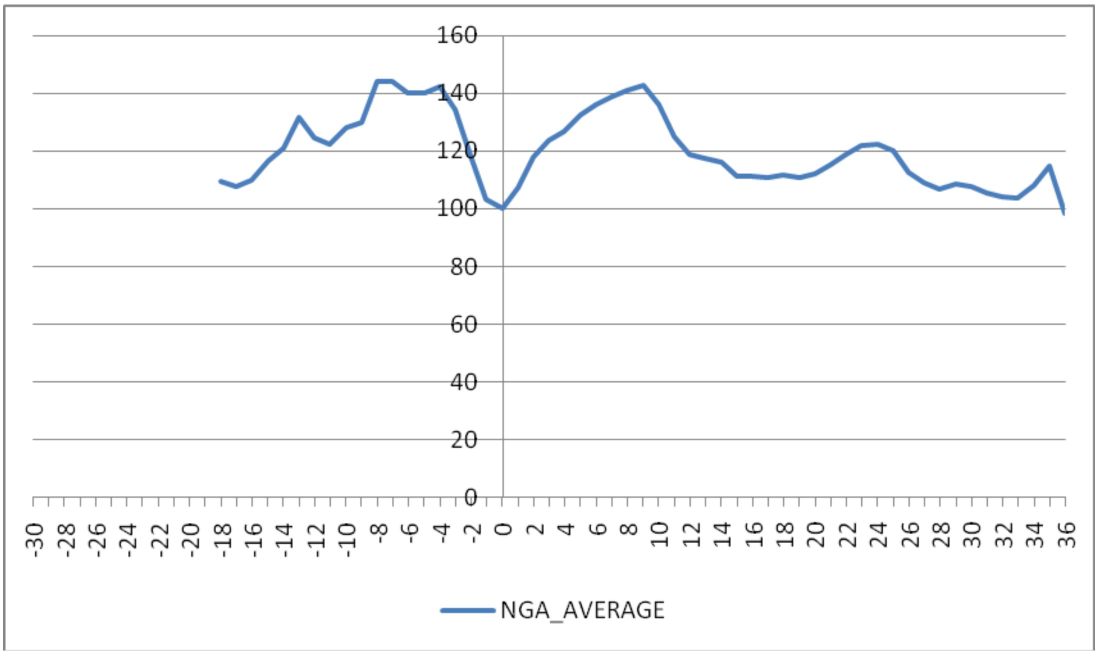


Figure 1.18: Norway as compared to Iceland, Austria, Denmark, Finland, France, Italy, Sweden, Ireland, Netherlands, Luxembourg, UK, USA, Spain, Greece, Belgium, Switzerland and Portugal, 1978=100

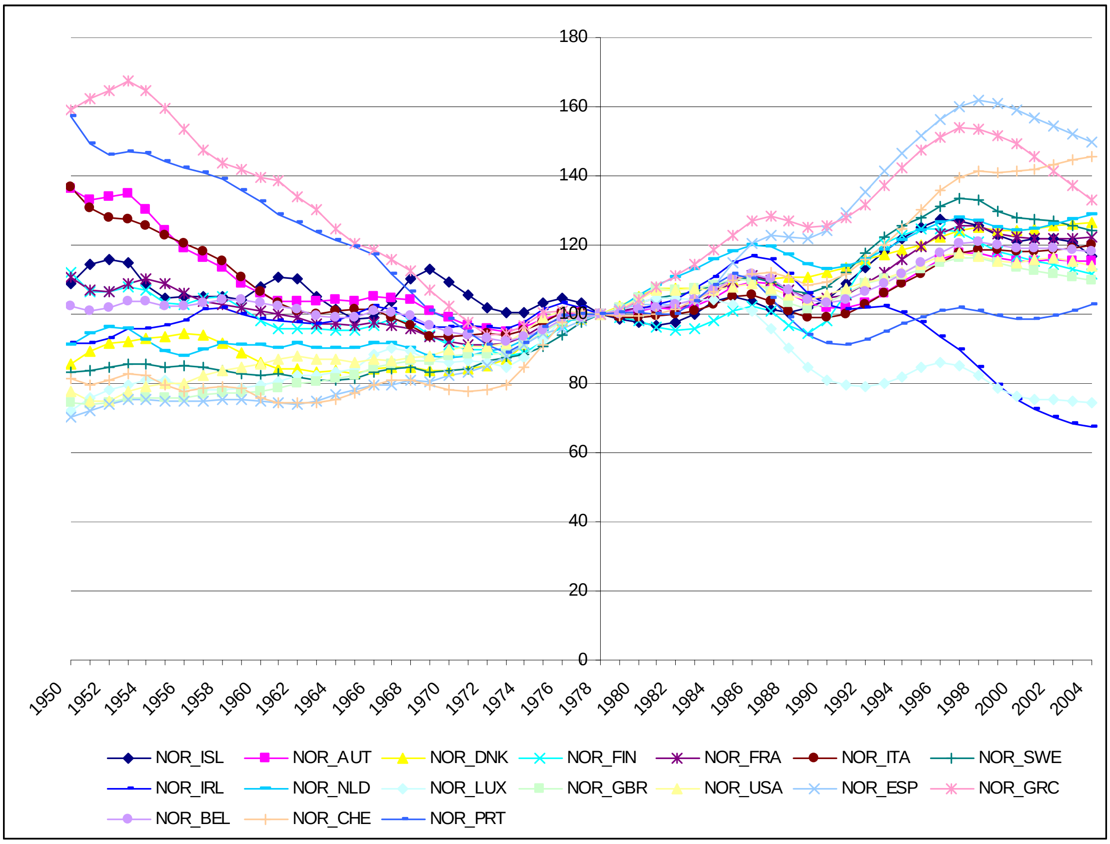


Figure 1.19: Norway as compared to the average Iceland, Austria, Denmark, Finland, France, Italy, Sweden, Ireland, Netherlands, Luxembourg, UK, USA, Spain, Greece, Belgium, Switzerland and Portugal, 1978=100

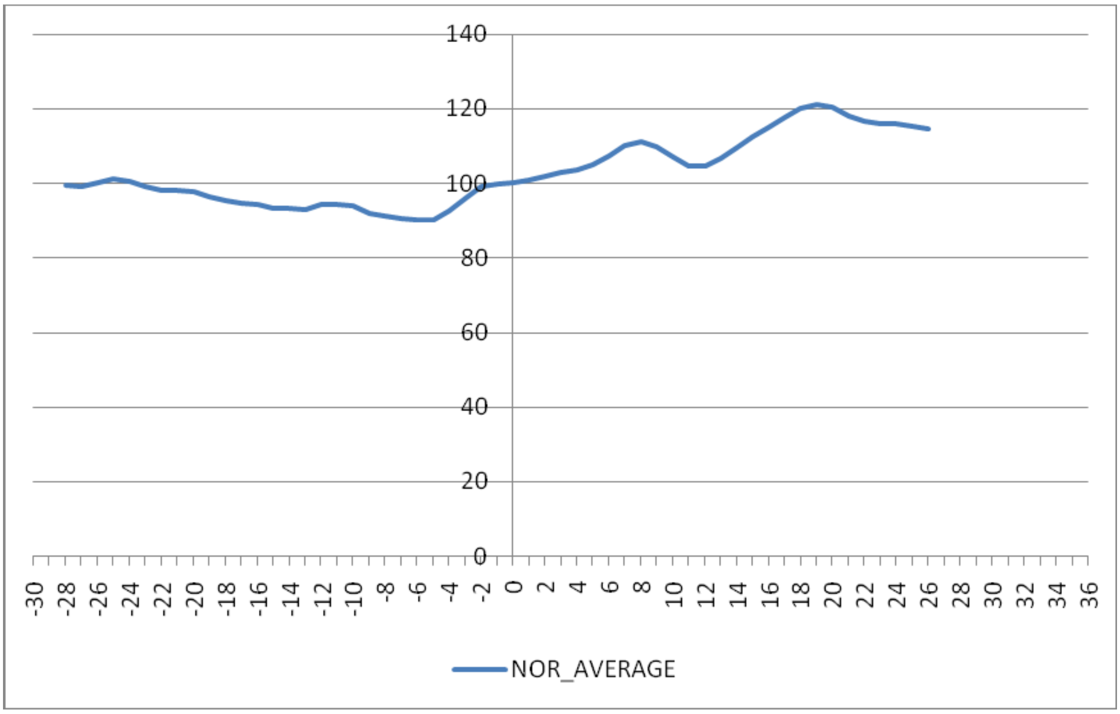


Figure 1.20: Senegal as compared to Sudan, 1980=100

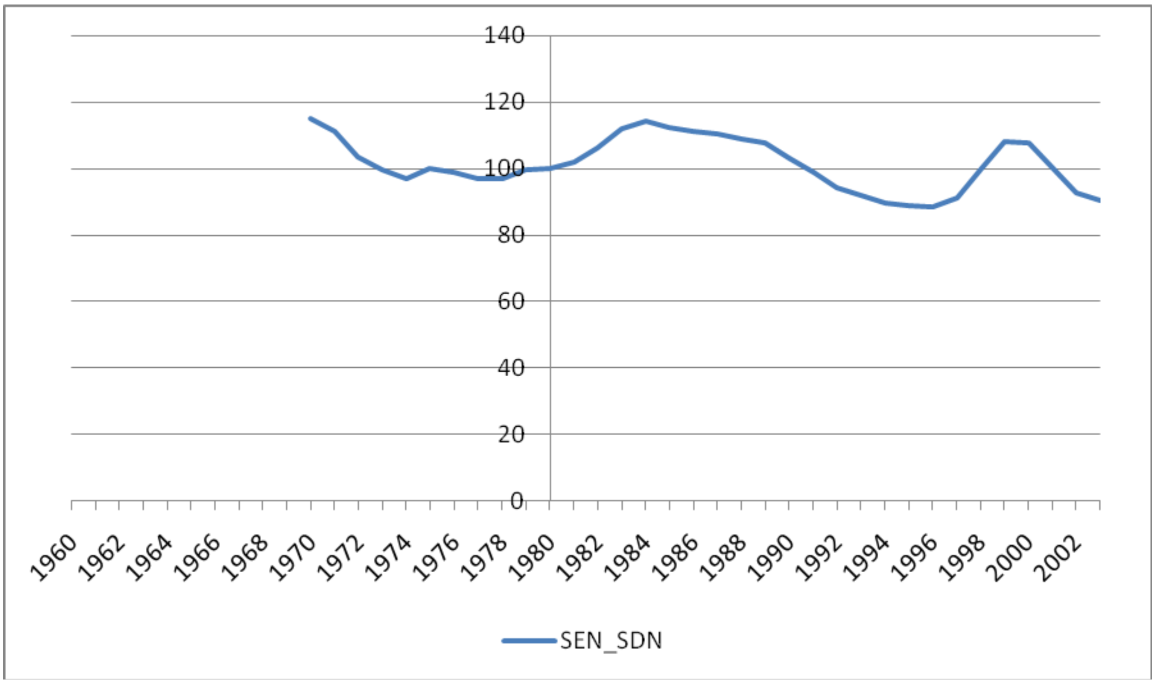


Figure 1.21: Togo as compared to Tanzania, Zambia, Malawi and Guinea-Bissau, 1982=100

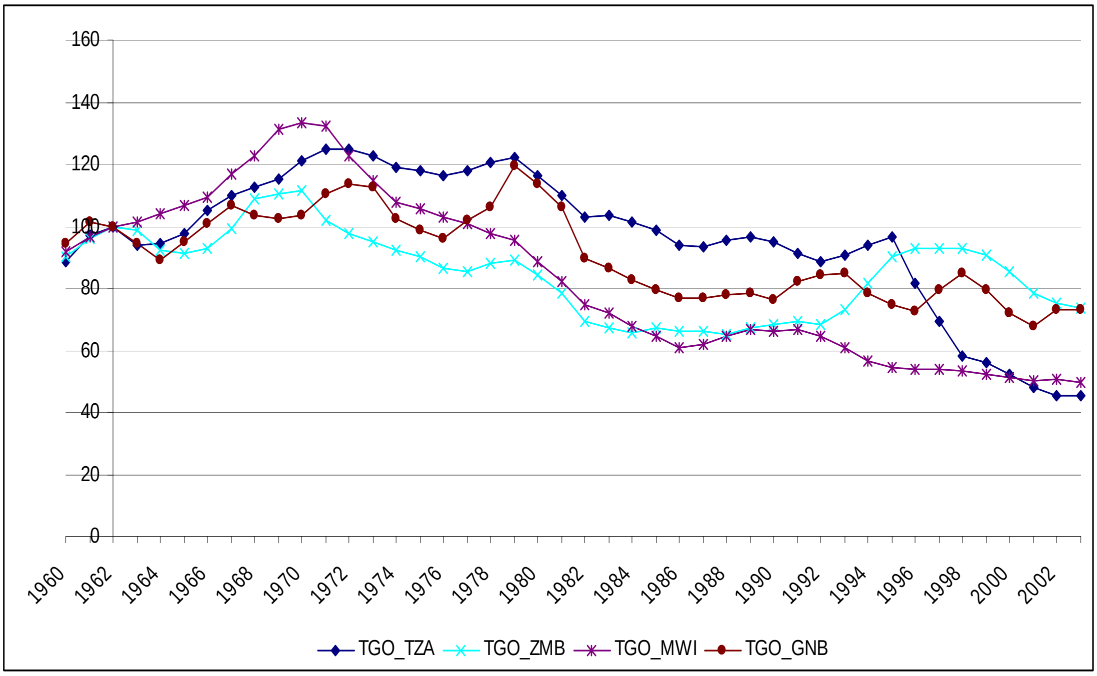


Figure 1.22: Togo as compared to the average of Tanzania, Zambia, Malawi and Guinea-Bissau, 1982=100

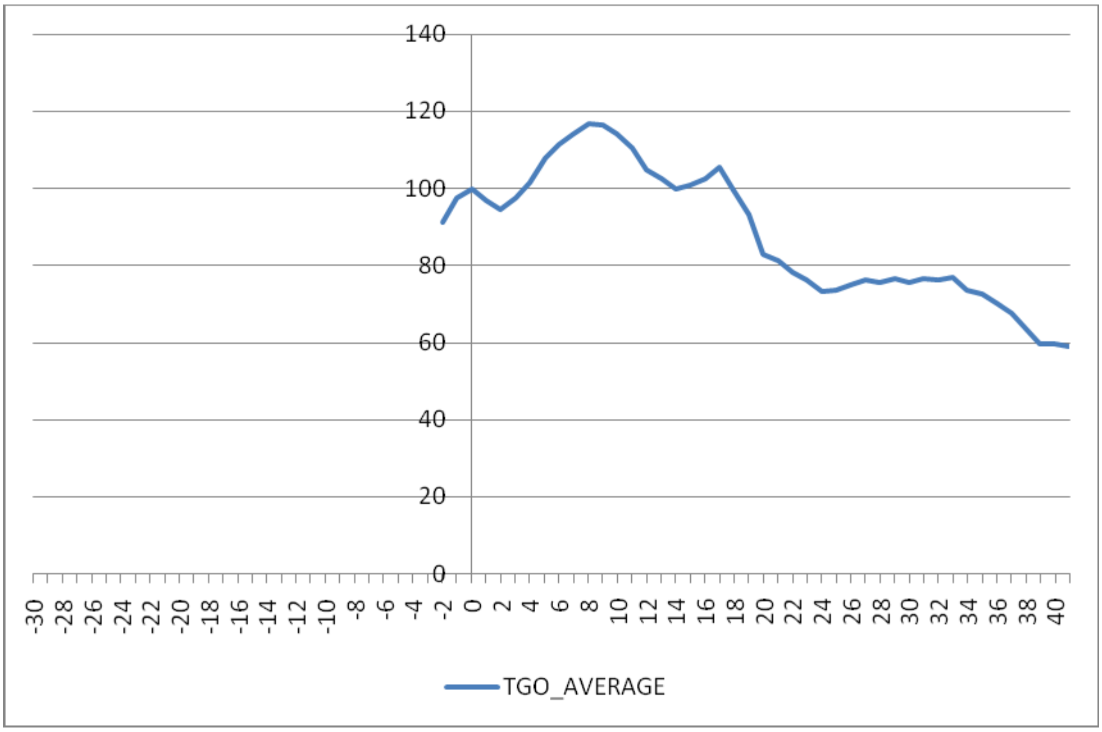
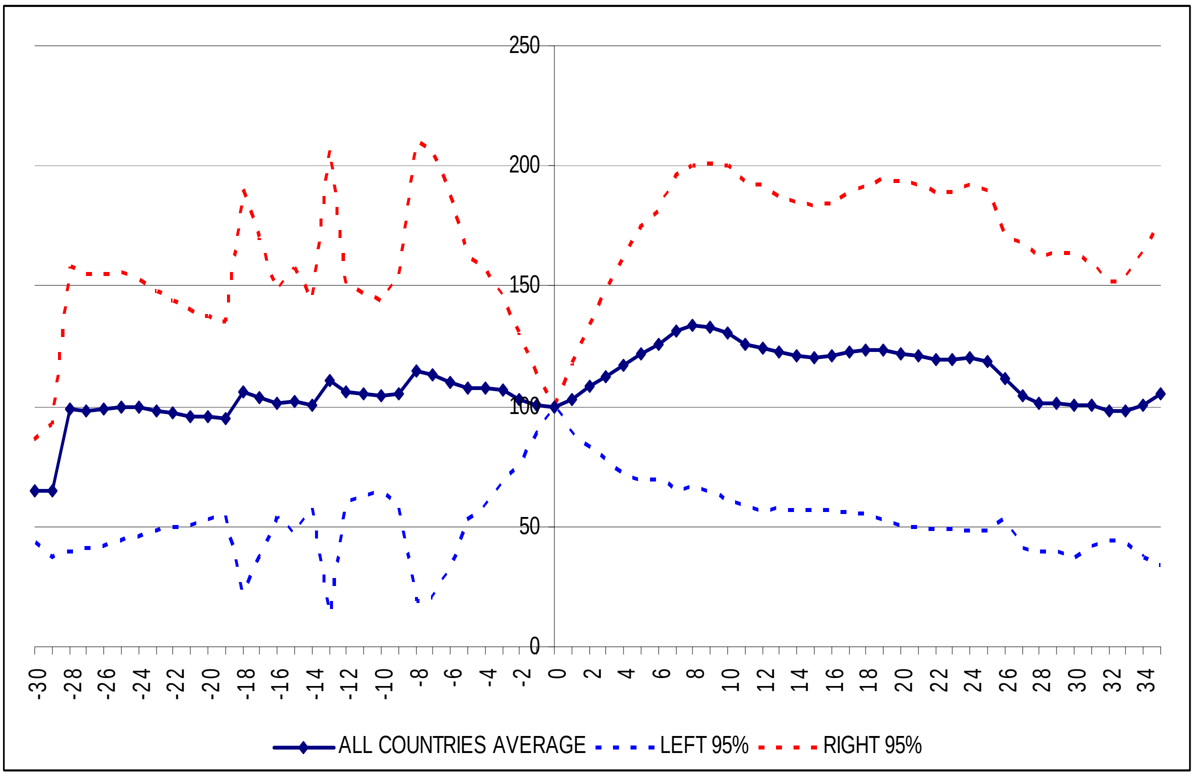


Figure 1.23: All countries average*, break date=100



*excluding last 6 years for Togo

1.10. Appendix

Assuming the equation (1.3) is applicable for the matched countries *i* and *j,* we write:

$Y_{it} = \delta_0 + X'_{it}\beta + \alpha R_{it} + \eta_i + \varepsilon_{it}$ - for country *i*

$Y_{jt} = \delta_0 + X'_{jt}\beta + \alpha R_{jt} + \eta_{ji} + \varepsilon_{jt}$ - for country *j*

Substarcting the second equation above from the first one yields:

$$Y_{it} - Y_{jt} = (X'_{it} - X'_{jt})\beta + \alpha(R_{it} - R_{jt}) + (\eta_i - \eta_j) + (\varepsilon_{it} - \varepsilon_{jt})$$

If countries *i* and *j* are successfully matched using minimum distance matching method, then the term $(X'_{it} - X'_{jt})$ becomes close to zero and irrelevant in the regression, and it could be dropped out. This is the major benefit of using the exact matching method so that multidimensional covariates could be controlled in a meaningful way.

Straightforwardly, denoting $\tilde{Y}_{ijt} = Y_{it} - Y_{jt}$, $\tilde{R}_{ijt} = R_{it} - R_{jt}$, $\tilde{\eta}_{ij} = \eta_i - \eta_j$ and $\tilde{\varepsilon}_{ijt} = \varepsilon_{it} - \varepsilon_{jt}$ would result in equation (1.4).

Chapter 2

Is Fiscal Policy Procyclical in Resource-Rich Countries?

2.1. Introduction

Recently, more attention in the literature has been devoted to analyzing the cycles of fiscal policy. The consensus is that, in developing countries fiscal policy is highly procyclical, whereas in developed countries it is less so, or is countercyclical (Lane and Tornell 1998, and Kaminsky, Reinhart and Vegh 2004). The key explanation of procyclical fiscal policy offered by the literature is based on „political economy" factors, such as rent-seeking and corruption (Gavin and Perotti 1997, Lane 2003, and Talvi and Vegh 2005). Henceforth, this is referred to as political economy aspects. Developed countries are equipped with stronger institutions and political systems, whereas developing countries rarely have strong, healthy and stable political institutions and problems associated with political economy factors are likely.

Given an absence of strong legal and political institutions in developing countries, Gavin and Perotti (1997), Tornell and Lane (1999) among others argue that the existence of multiple powerful groups fighting over fiscal transfers would lead to a more than proportional increase of fiscal redistribution in case of favorable shocks, resulting in inefficient capital projects. Powerful groups will try to access income to the extent that they can via the fiscal process. Also, according to Alesina, Campante and Tabellini (2008), voters do not trust a corrupt government, which can appropriate tax revenues for unproductive consumption expenditures. Therefore, if the economy is booming, voters tend to demand immediate benefits, as they believe that the government would steal it through political rents. This leads to procyclical fiscal policies. Alesina et al (2008) show that the procyclicality of fiscal policy is more pronounced in corrupt democracies where voters can hold their governments accountable.

Another commonly accepted explanation of fiscal policy procyclicality is that developing countries usually face borrowing constraints on the international financial markets (e.g. Aizenman, Gavin and Hausmann 2000, Gavin and Perotti 1997). During unfavorable times, developing countries may face tighter credit constraints which may necessitate cuts in their expenditures, leading to procyclicality. Here, explanations based on political economy and borrowing constraints cannot be independent from each other, nor are they substitutes. A natural question is why credit-constrained governments do not save in favorable times, anticipating that in unfavorable times they will have to cut their expenditures significantly. To answer this question, we should consider the political and institutional environments in those countries. The procyclicality of fiscal policy is directly related to a governments' failure to save in favorable times.

In the current research, we analyze fiscal policy procyclicality in resource-rich developing economies. Resource richness may bring out and intensify the two types of effects, political economy and borrowing constraint, on fiscal policy procyclicality. As argued in the literature, resource richness may induce rent-seeking and corrupt behavior by a government, increasing the procyclicality of the fiscal policy. For example, Karl (1999) observes that the governments of oil exporting countries have less incentives to be frugal, efficient, and cautious in policymaking. Access to easy money stemming from oil revenues weakens institutions and decreases fiscal discipline. In the case of resource abundance, the common pool problem becomes more severe and fighting over resources intensifies, as argued in Alesina, Campante and Tabellini (2008). The governments of resource-rich countries may come under constant political pressure to spend revenues resulting from raising resource prices. In the case of lower resource prices, maintaining high levels of government spending may not be possible, leading to significant cuts. Eifert, Gelb and Tallroth (2003) discuss how different political systems can lead to different fiscal policy behaviors in resource-rich countries. As they argue, mature democracies or reformist autocracies are better able to smooth the government expenditures across cycles and thus run a less procyclical fiscal policy, whereas other political systems may have difficulties in this respect.

Despite their negative effects on rent-seeking and corruption, discoveries of natural resources can be considered a windfall to governments, because the resource sector is usually owned by the government. Such ownership provides extra "fiscal space" to governments, which they can use to finance their expenditures. In such a case, to increase public spending today, the government need not decrease spending in the future. The government would have an additional opportunity to save in "good times" and therefore to pursue a less procyclical fiscal policies in "bad times". Many resource-rich countries could build vast international reserves from their resource revenues. Karmann and Maltritz (2004) relate the ability of a government to pay its debt and default risk to its foreign exchange reserves. Owning significant reserves may help governments to decrease expenditures less in case of negative shocks to the economy by alleviating the borrowing constraint. In light of this, Zhou (2009) argues that, in developing countries, political risk, cyclicality of fiscal policies, and their level of international reserves are strongly related to each other. Moreover, even the "least" creditworthy resource-rich countries are able to cash in on their natural resources. For example, despite being assigned very low credit ratings, Bolivia, Venezuela and Iran export their oil and gas resources as there is a global demand.[5]

The contribution of this study is in documenting a strong non-linear U-shaped relationship between resource richness and fiscal procyclicality. Up to a certain level of resource richness, fiscal procyclicality declines, and afterwards it increases. Although the literature predicts a somewhat linear relationship between resource richness and weaker political institutions, and hence higher fiscal procyclicality, we claim that resource richness can decrease fiscal procyclicality by alleviating the borrowing constraint. We argue that the two key reasons for fiscal procyclicality, political economy frictions and borrowing constraint, create two opposite effects stemming from resource richness. This may well be the reason for the U-shaped pattern. We present empirical evidence that is consistent with the above-mentioned hypotheses. We develop a rather simple theoretical framework that addresses these hypotheses and, consequently, generates a U-shaped pattern.

The chapter is organized as follows: the next section discusses procyclicality in resource-rich countries, documents the key observations, and outlines the basis for the main hypotheses. In Section 2.3, we provide important empirical evidence that is consistent with our story and hypotheses. Section 2.4 builds a model that incorporates these hypotheses and discusses the model-driven results. Section 2.5 concludes.

[5] As of September 2009, Moody's assigned a very low credit rating of B2 to the governments of Venezuela and Bolivia for their foreign currency bonds. Iran was not assessed.

2.2. Fiscal procyclicality in resource-rich countries

First of all, a relevant measure should be defined to analyze fiscal policy cyclicality, as there is not one readily available and this needs to be estimated. Such a cyclicality measure could be estimated using different fiscal aggregates such as primary fiscal balance, government expenditures, or tax revenues, and using different estimation methodologies.

Here, we will use total government expenditures and their components for our analysis. Using revenue side variables may not best suit for fiscal procyclicality analysis in resource-rich developing countries due to several reasons. First, tax collection is costly and requires a strong tax infrastructure in place, which requires significant investments in this area. As a large part of government revenues consists of resource revenues, and governments of resource rich countries rely heavily on resource revenues, the tax infrastructure of such countries is usually weak. In this case, tax rates as a fiscal policy instrument become ineffective. Second, in resource rich countries, separation of resource and non-resource tax revenue is a challenge. Separation of the revenue types is important, as resource revenues are mostly driven exogenously, whereas non-resource revenues depend mainly on domestic fiscal policy and tax infrastructure. Usually, resources are produced by government-owned enterprises. Taxes paid by a state-owned company operating in oil production is also revenue stemming from resources, although it is reported as tax revenue. This diminishes the role of tax revenues and rates as the fiscal policy indicators.

According to Kaminsky et al (2004), from a theoretical point of view, government expenditures and tax rates are most suitable indicators for studying fiscal cyclicality. However, in practice, as they argue, there is no systematic tax rates data, and hence, government spending is the best indicator to be used in estimating fiscal policy procyclicality.

Overall, the most suitable fiscal variable for fiscal policy cyclicality analysis in the context of our work is government expenditures. To obtain the cyclicality measure we run the following regression between the growth of real government expenditures and real GDP growth[6], similar to Woo (2009).

$$\ln G_{it} - \ln G_{it-1} = \delta_i + \beta_i[\ln Y_{it} - \ln Y_{it-1}] + \varepsilon_{it} \tag{2.1}$$

Along with the cyclicality measure for real total government expenditures (*beta_rtote*), we obtain cyclicality measures for real government current (*beta_rcure*) and capital expenditures (*beta_rcape*). The summary of obtained cyclicality measures - β's, is reported in Table 2.1 below. Although we started with 170 countries, due to data limitations we were able to obtain cyclicality measures for only 99 countries. For some countries, there are only 4 years of observations during the 1970-2007 period. As a low number of observations leads to larger errors in obtained cyclicality measures, for some countries the measure may not be representative. Therefore, to get a more reliable measure we decided to use only the sample of countries which have at least 20 years of observations, reducing the number of countries in our study to 61.

Table 2.1 demonstrates that, consistent with the existing literature, government expenditures for non-OECD countries are on average more procyclical, whereas for OECD countries they are less procyclical, and even countercyclical. This result holds not only for total expenditures, but also for current and capital expenditures. Also, for all country groups – both OECD and non-OECD countries - the capital expenditures are

[6] See Appendix 2.A for a detailed description

more procyclical than current expenditures. The same applies for resource-rich and resource-poor countries as well. This is not surprising, as the real business cycles literature documents much higher volatility for capital expenditures than for current expenditures.

Table 2.1: Averages of betas obtained through (2.1), for countries that have at least 20 years of government expenditure data

	beta_rtote	**beta_rcure**	**beta_rcape**	**Growth volatility 1960-2003**
All countries	0,526	0,402	1,390	1,798
OECD	-0,038	-0,063	0,367	1,122
Non-OECD	0,868	0,678	2,051	2,089
Group 1: Resource-poor non-OECD	0,968	0,849	2,288	1,834
Group 2: Resource-rich[1)] non-OECD	0,713	0,490	1,752	2,519
Group 3: Resource-rich[1)] OECD	0,429	0,350	1,289	0,993
Group 4: Resource-poor OECD	-0,136	-0,154	0,162	1,143

1) A country is considered to be resource-rich if the average mineral exports share in total merchandise exports during 1961-2000 is higher than 20 percent. Otherwise the country is defined as resource-poor.

The table also shows that, within the resource-rich group, resource-rich non-OECD countries have higher procyclicality than resource-rich OECD countries. Non-OECD countries have generally weaker institutions than do OECD countries. As argued in the literature, resource richness creates enormous financial wealth that may foster corruption and rent seeking. This is consistent with the ***political economy*** story in the literature, which argues that developing countries with weak institutions may suffer more in correlation with resource richness. Karl (1999) discusses the political problems facing the oil-producing countries, including low fiscal discipline, rent seeking, and corruption, due to access to easy money by the political authorities. Leaders of oil-producing countries can afford to be less efficient and cautious in policymaking. Eifert, Gelb and Tallroth (2003) describe the autocratic regimes in different oil-exporting countries that fail to save enough during booms and therefore run procyclical fiscal policies.

The statistics in Table 2.1 for resource-rich and poor country groups within OECD and non-OECD countries gives an even more interesting picture. Within OECD, for the resource-rich countries a government's total expenditures and its components are more procyclical than for resource-poor countries. However, for non-OECD countries, the opposite is true. This implies that resource richness facilitates different types of fiscal behavior for the governments of OECD countries as compared to those of non-OECD countries. This result is somewhat surprising, as the literature implicitly predicts a more procyclical fiscal policy with more resource abundance due to the common pool problem. Even if the common pool problem exists, this result suggests that another effect may exist that decreases procyclicality with resource richness.

In this context, to explain the observation that resource-rich developing countries may run less procyclical fiscal policies than resource-poor developing countries, the ***borrowing constraint alleviation*** story is more plausible. This mechanism suggests that if a country is not facing a credit constraint, it can borrow during unfavorable shocks so as not to decrease government expenditures with the business cycle, and therefore run a less procyclical or countercyclical fiscal policy[7]. Consequently, if a country is constrained, procyclical fiscal policy is more likely. Governments that own mineral resources and the foreign exchange stemming from it should be able to finance

[7] Here, it is assumed that it is optimal to run countercyclical or acyclical fiscal policies. Although, the countercyclical fiscal policy is preferred, Perotti (2007) summarizes situations when a procyclical fiscal policy can be optimal. Such optimality mainly assumes a distortionary role of the government for the private sector of the economy.

the expenditures. Also, many resource-rich countries have built vast international reserves from resource exports. From an international investor perspective, governments that own huge wealth are less likely to default, which increases the investors' willingness to lend. It might be the case for developing countries that a country richer in mineral resources will face a less tight borrowing constraint.

In order to build our political economy and borrowing constraint stories, we make two crucial assumptions. First, we assume that OECD countries face looser or no borrowing constraints compared to non-OECD countries. The second assumption is that OECD countries have strong institutions that can effectively limit rent-seeking and corruption. Table 2.2 clearly shows the plausibility of these assumptions. As an indicator of borrowing constraint, if we look at the government bond ratings assigned by Moody's to the OECD countries, it is on average AA2, whereas in non-OECD countries it is very significantly worse, averaging around BAA3. The data on governance and institutional quality by the World Bank clearly indicates highly significant differences between OECD and non-OECD country groups in all these measures.

It is also important that the political economy situation and a government's borrowing constraints are strongly related to each other. Arguably, a government that is rent seeking and corrupt is likely to face tighter borrowing constraints. If the institutional environment is unable to control corruption or rent seeking, then resource richness can lead to even tighter borrowing constraints, in contrast to the borrowing constraint alleviation described above. However, the borrowing constraint alleviation story in our hypothesis can be understood as a "wealth" effect with resource ownership. Resource-rich governments possess significant resource wealth that increases their fiscal sustainability, which in turn helps to alleviate borrowing constraints.

Table 2.2. Government bond ratings and institutional quality in OECD vs. Non-OECD

Indicators[8]	All countries	OECD countries	Non-OECD countries
Bond ratings by Moody's, September 2009	BAA1	AA2	BAA3
Government effectiveness	0.003	1.521	-0.337
Control of corruption	0.055	1.473	-0.350
Voice and accountability	-0.040	1.222	-0.312
Political stability	-0.110	0.876	-0.334

Given that there are at least two effects, as stated in our hypotheses, stemming from resource ownership in developing countries, we would expect a non-linear or non-monotonous relationship between procyclicality and resource richness, whereas for OECD countries the relationship is expected to be different and possibly non-existent. Below, Figure 2.1 to Figure 2.3 show a direct relationship between fiscal policy cyclicality and resource richness. As a resource richness measure, we use mineral exports share in total merchandise exports between 1961 and 2000 (*min6100*) taken from WDI.[9]

Interesting patterns emerge. In Figure 2.1, we observe a somewhat U-shaped pattern in the betas for total government expenditures with respect to resource richness. In Figure 2.2, there is no clear pattern for current expenditures cyclicality. However, Figure 2.3 suggests that there is a clear U-shaped relationship between resource richness and capital expenditure cyclicality in non-OECD countries.

[8] Please refer to the data appendix for the detailed description.
[9] Appendix 2.A contains a more detailed data description.

Figure 2.1: The cyclicality of total government expenditures in non-OECD countries – for countries that have at least 20 years of government expenditure data

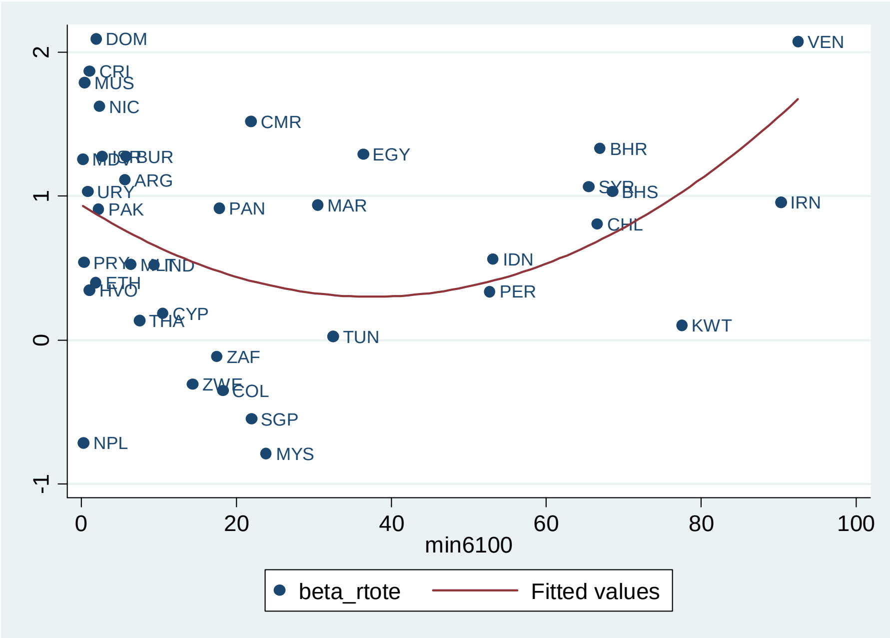


Figure 2.2: The cyclicality of current government expenditures in non-OECD countries – for countries that have at least 20 years of government expenditure data

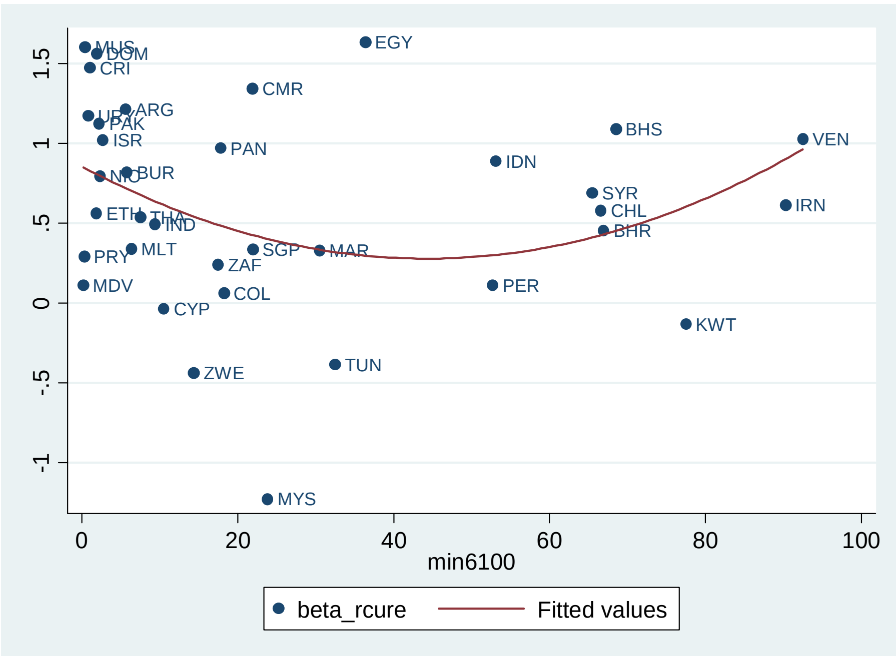
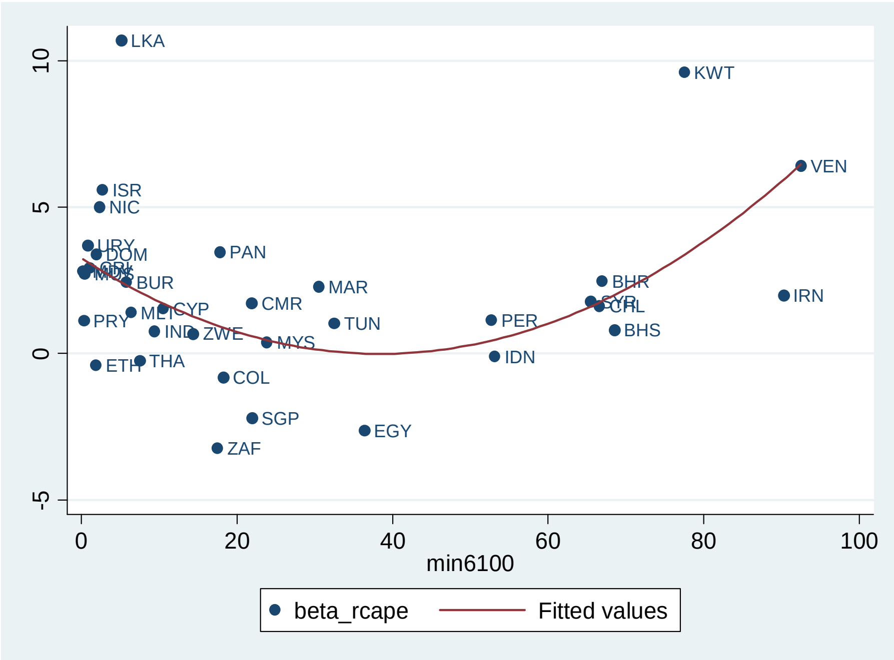


Figure 2.3: The cyclicality of government capital expenditures in non-OECD countries – for countries that have at least 20 years of government expenditure data



To check the statistical significance of the U-shaped pattern, Table 2.3 below reports the simple regression relationship between fiscal procyclicality and the resource richness measure with its squared term.

Table 2.3: OLS regressions - Government expenditures procyclicality measures vs. resource richness, for non-OECD countries that have at least 20 years of government expenditure data

	beta_rtote		beta_rcure		beta_rcape	
MIN6100	-0,0017 (-0,25)	-0,0415 (-1,81)*	-0,0042 (-0,84)	-0,0261 (-1,50)	0,0094 (0,53)	-0,1651 (-3,03)***
MIN6100_2	-	0,0005 (1,81)*	-	0,0003 (1,32)	-	0,0022 (3,34)***
Adjusted R_squared	0,00	0,03	0,00	0,01	0,00	0,22
# of obs	38	38	37	37	35	35

t-stats are in the brackets under coefficients. Variables: **MIN6100** – fuels and ores and metals exports share in total merchandise exports over the 1961-2000 period, **MIN6100_2** - the square of min6100.

From Table 2.3 it can be seen that resource richness alone does not explain the cross-country differences in fiscal cyclicality. Interestingly, inclusion of the squared term of resource richness variable changes the picture significantly; both the resource richness and its squared term become statistically significant. This is especially true for the betas of capital expenditures, though the betas for current expenditures also exhibit some level of statistical significance. This confirms that procyclical current expenditures can create more political pressure; thus governments prefer to smooth the current expenditures along the business cycles more than capital expenditures. Possibly, the capital expenditures are of a more discretionary nature.

We also perform a robustness check for the estimation of our procyclicality measures. Specifically, as an alternative to the main method, we estimate the procyclicality measure as the correlation between the cyclical components of GDP and government expenditures. Having done so, we confirm the U-type relationship between procyclicality and resource richness. Appendix 2.B provides further details.

We also check whether such a U-shaped relationship persists if we use alternative measures of resource richness. For this, we turn to three additional measures used in the literature: the share of primary products in GNP; the share of mineral production in GNP (borrowed from Sachs and Warner 1997); and the fraction of GDP produced in the Mining and Quarrying sector (borrowed from Sala-i-Martin et al 2004). Detailed description of the data can be found in the Appendix 2.A. Table 2.4 below checks the existence of U-shaped dependence between capital expenditure procyclicality and those resource richness measures.

Table 2.4: OLS regressions - Government capital expenditures procyclicality measures vs. alternative resource richness measures, for non-OECD countries that have at least 20 years of government expenditure data

	Dependent variable: government capital expenditures procyclicality - beta_rcape							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SXP	0,0941** (2,70)	0,0197 (0,19)	-	-	-	-	-	-
SXP_2	-	0,0011 (0,79)	-	-	-	-	-	-
SXP80	-	-	0,1023** (2,66)	0,0351 (0,33)	-	-	-	-
SXP80_2	-	-	-	0,0011 (0,67)	-	-	-	-
SNR	-	-	-	-	0,0690* (1,94)	-0,1755 (1,81)*	-	-
SNR_2	-	-	-	-	-	0,0046 (2,79)**	-	-
MINING	-	-	-	-	-	-	0,1027 (1,30)	-0,3173 (1,82)*
MINING_2	-	-	-	-	-	-	-	0,0175 (2,65)**
Adjusted R_squared	0.16	0.15	0.17	0.15	0.08	0.23	0.02	0.18
# of obs	33	33	31	31	33	33	33	33

t-stats are in the brackets under coefficients. Regression (3) excludes BHS and BHR which has extremely high SXP80, more than 100%. Variables: **SXP** – the share of primary products in GNP in 1971 (**SXP_2 -** its squared term), **SXP80** – the share of primary products in GNP in 1980 (**SXP80_2** – its squared term), **SNR** – the share of mineral production in GNP in 1971 (**SNR_2** – its squared term), **MINING** – the fraction of GDP produced in the Mining and Quarrying sector (**MINING_2** – its squared term).

The results in columns (2) and (4) show that there is no U-shaped pattern for the share of exports of primary products in GNP (SXP and SXP80). Instead, there is a strong positive linear dependence as shown in columns (1) and (3). On the other hand, columns

(6) and (8) exhibit a statistically significant U-shaped relationship for the share of mineral production in GDP (SNR) and for the fraction of GDP produced in the Mining and Quarrying sector (MINING).

In order to interpret the differences in results, it is important to understand the differences in the measures of resource abundance. In general, we have considered two categories of resource abundance measures based on: 1) primary products (such as SXP and SXP80); and 2) mineral products (such as SNR, MINING and MIN6100). Mineral products are perceived to be exhaustible; primary products include both exhaustible and non-exhaustible resources. We claim that these differences originate from the nature of the resource abundance measures. According to the Standard International Trade Classification, primary products are broader than mineral products, the latter including: food and live animals (SITC 0), beverages and tobacco (SITC 1), crude materials, inedible, except fuels (SITC 2), mineral fuels, lubricants and related materials (SITC 3), animal and vegetable oils and fats (SITC 4) and non-ferrous metals (SITC 68). Mineral goods may have a different ownership structure than non-mineral primary goods. Mineral resources are mainly owned by national governments or by state enterprises. McPherson (2003) claims that 90% of oil reserves are controlled by national oil companies, accounting for 73% of oil production globally. According to the U.S. Energy Information Administration, national oil companies controled 88% of global oil reserves and at least 55% of the oil production in 2010. This fact translates into significant export earnings from resources accruing into government accounts, whereas earnings from non-mineral resources exports, such as agricultural products, are collected partially through taxes. Therefore, these two categories of resources may have different fiscal implications (Aliyev, 2011).

2.3. Empirical observations

To summarize the hypotheses described in the previous section, for non-OECD countries with mineral resource ownership two effects kick in for fiscal policy procyclicality: 1) political economy problems, such as rent seeking and corruption; 2) credit constraint alleviation. In this section, we provide empirical support for those hypotheses.

2.3.1. Resource richness and institutions

We now turn our attention to the first hypothesis, the existence of a positive relationship between resource richness and political economy problems. As previous studies have found, we would expect resource richness to induce rent seeking and corrupt behavior by a government. We check whether a direct relationship exists between resources, control of corruption, and a government's effectiveness measures. Table 2.5 serves this purpose.

Table 2.5: OLS regressions – Institutional quality vs. resource richness, non-OECD countries

	Control of corruption	Government effectiveness	Voice and accountability	Political stability
MIN6100	-0,0081 (-3,10)***	-0,0069 (-2,76)***	-0,0096 (-3,65)***	-0,0073 (-2,32)**
LGDPEA70	0,5575 (5,71)***	0,5631 (6,07)***	0,5022 (5,21)***	0,4717 (4,10)***
Adjusted R-squared	0,285	0,279	0,243	0,148
# of obs	82	93	94	94

t-stats are in the brackets under coefficients. Variables: **MIN6100** - fuels and ores and metals exports share in total merchandise exports over the 1961-2000 period, **LGDPEA70** – the log of per capita GDP in 1970.

The regression columns in Table 2.5 indicate that resource richness is significant in explaining corruption and government effectiveness. We include initial per capita income (log of per capita GDP in 1970) as an additional control variable. In high income countries, control of corruption and government effectiveness would be high, and therefore, create bias in the estimation. The coefficients are highly statistically significant and have the expected sign. In this case, the results tell us that resource richness decreases control of corruption, government effectiveness, voice and accountability, and political stability, as was expected.

In most cases, rich countries have strong political and economic institutions in place. They are characterized by clear property rights, high control of corruption, contained rent seeking, and more effective governments. Generally, government investments are complements, not substitutes, for private investments. Under these circumstances, such governments pursue long-horizon policies which help them efficiently use resource revenues. OECD countries are considered to be rich and mature democracies. However, a few rich non-OECD countries with strong institutions do exist, including Singapore, Chile (which recently became an OECD member) and Malaysia. These countries enjoy a high level of transparency in their political systems, enabling them to run effective economic and fiscal policies.

Below, Figure 2.4 and Figure 2.5 visualize the negative relationship between political economy variables and resource richness for the poorer non-OECD countries, i.e. those that had lower GDP per capita in 1970 than the average OECD measure.

Figure 2.4: Control of corruption during 1996-2008 vs. resource richness measure MIN6100: for resource-rich non-OECD countries that had per capita GDP lower than average OECD in 1970

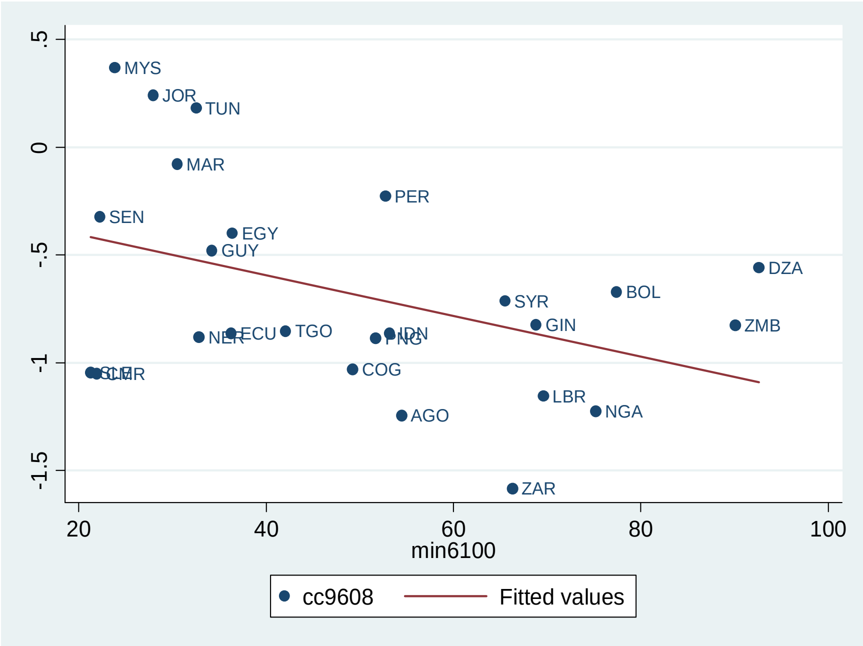
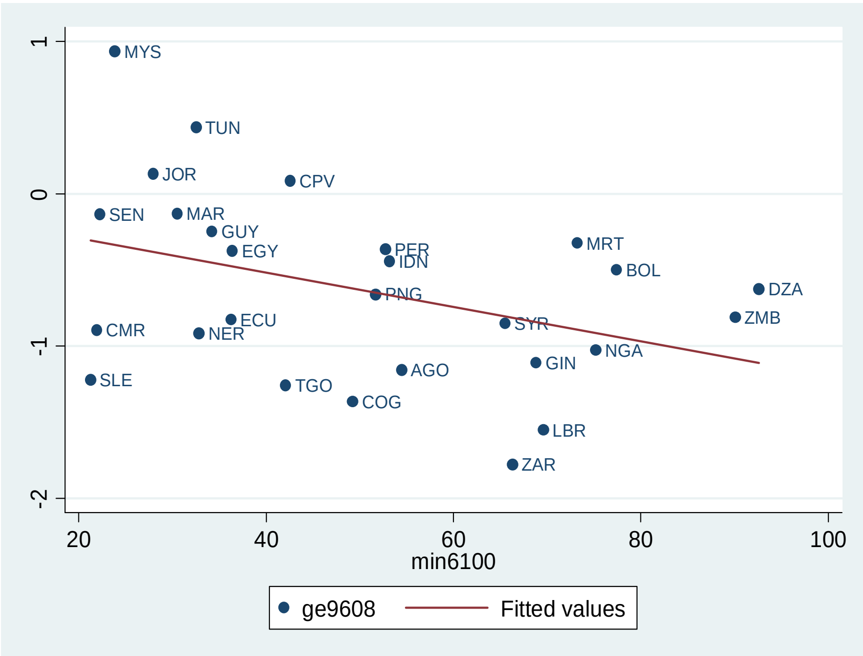


Figure 2.5: Government effectiveness during 1996-2008 vs. resource richness measure MIN6100: for resource-rich non-OECD countries that had per capita GDP lower than average OECD in 1970



In general, commodity shocks, either of price or production nature, often can be very large, leading to very significant swings in economic growth and government revenues. In order to avoid a highly procyclical fiscal policy, such shocks may necessitate running large fiscal surplus or deficits. This may not always be possible. If a government is not credible and trustworthy, it cannot successfully defend running large surpluses during favorable times and hence increases its expenditures to appease the public. In unfavorable times, if it cannot borrow, it must cut its expenditures significantly.

2.3.2. Resource richness and borrowing constraint

In this section we look at the credit constraint alleviation hypothesis. First, we need to have a measure for credit constraint. Here, we use Foreign-Currency Government Bond Ratings issued by Moody's Investors Service, as such a measure "reflects the government's capacity and willingness to mobilize foreign exchange to repay its foreign-currency denominated bonds on a timely basis" (Moody's Investors Service 2006). These ratings are not published numerically, so we assign numerical values to the issued ratings between 1 and 19, with 1 representing the least constrained governments. We then look at the relationship between the mineral export share and government bond ratings issued by Moody's, shown in Table 2.6.

The table shows that the coefficient is negative and significant at conventional levels, meaning that more resource richness is associated with more positive bond ratings. As expected, bond ratings, i.e., borrowing constraint, are determined by many other important factors. One undeniable factor is the institutional and political economic situation of the country, which should be included as a control. From this we surmise that institutional development might be dominating resource richness in the determination of the ratings. For example, though Venezuela is very resource rich, it also has poorly-developed institutions which are probably a key determinant of its very low assigned bond ratings.

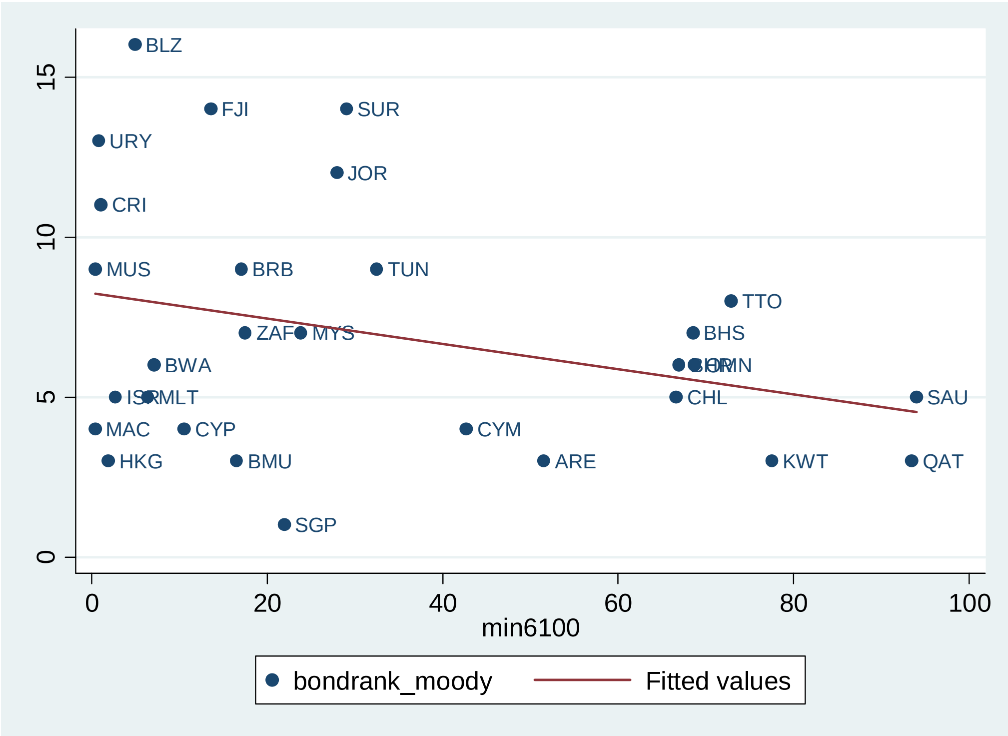
Table 2.6: OLS regressions – Government bond ratings vs. resource richness, non-OECD countries

	Dependent variable: Foreign-Currency Government Bond Ratings issued by Moody's in September 2009				
MIN6100	-0,0385* (-1,75)	-0,0254* (-1,95)	-0,0417*** (-3,57)	-0,0330* (-1,99)	-0,0391** (-2,68)
CC9608	-	-4,705*** (-9,58)	-	-5,0684*** (-8,76)	-
GE9608	-	-	-5,5443*** (-11,17)	-	-5,7557*** (-10,63)
LGDPEA70	-	-	-	1,3539* (1,76)	1,0026 (1,54)
Adjusted R-squared	0,04	0,66	0,72	0,66	0,73
# of observations	57	51	53	42	43

t-stats are in the brackets under coefficients. Variables: **MIN6100** - fuels and ores and metals exports share in total merchandise exports over 1961-2000 period, **GE9608** – government effectivenes during 1996-2008, **CC9608** – control of corruption during 1996-2008, **LGDPEA70** – the log of per capita GDP in 1970.

Inclusion of the institutional development measure, such as control of corruption or government effectiveness, improves the significance of resource richness on bond ratings. Figure 2.6 below shows how the ratings differ by resource richness for non-OECD countries; the relationship is negative. In this graph, we select only those countries that have at least some level of institutional development (i.e., *cc9608*>0) in order not to "lose" the visualization of the correlation between bond ratings and resource richness. The result is also consistent with the literature. Daud and Podivinsky (2011) find that accumulation of reserves has a positive impact on sovereign ratings.

Figure 2.6: Foreign currency government bond ratings by Moody's as of September 2009 vs. resource richness measure *min6100*: Non-OECD countries that have "some" control of corruption (*cc9608*>0)



Above, we provided supporting evidence for both of the resource impact channels on fiscal procyclicality. These channels are considered separately. Putting borrowing constraint and institutional quality measure into one equation together with their interaction term with resource richness variable would create conceptual obstacles in understanding the impacts. This is because it is difficult to find borrowing constraint and institutional quality measures that are independent of resource richness. We believe that resources affect both borrowing constraint and institutions. Hence, creating a more comprehensive econometric approach to estimate the impacts from those two channels would be challenging.

2.4. Theoretical framework

The U-shaped pattern which is the outcome of the empirical analysis above is not an obvious one. We want to design a rather simple and intuitive framework that would demonstrate why U-shape relationship may prevail. In this section, we build a simple theoretical model that incorporates the two hypotheses developed in the previous sections into one framework. Under these settings, we are able to obtain a U-shaped relationship between the procyclicality of government consumption and resource richness. Although the most significant U-shaped pattern is obtained with capital expenditures, as argued in the literature, those expenditures are actually consumption expenditures. For example, Talvi and Vegh (2005) claim that the public investments associated with commodity booms should be viewed as government consumption, as those non-productive investments fail to generate future consumption.

We consider a two-period social planner model. The government receives revenues from the resource sector Z as endowment and from the stable non-resource sector T as tax collections, and it can borrow B. The initial period budget constraint is:

$$C_0 = Z_0 + T + B \qquad (2.2)$$

In the last period, to finance consumption C_1 it receives unchanged tax income T and resource income Z_1, and it has to fully repay its debt. Moreover, the government of the developing country faces a borrowing constraint in the international marketplace. To formalize the idea of credit constraint faced by governments when borrowing, we adopt the following representation that the higher the debt amount, the more interest it requires:

$$C_1 = Z_1 + T - R\left(\frac{B}{\overline{Z}}\right)B \tag{2.3}$$

Here, $R\left(\frac{B}{\overline{Z}}\right)$ is the interest rate, which is an increasing convex function, $R'(\cdot) > 0$ and $R''(\cdot) > 0$. Such a formalization implies limits on borrowing as the cost of serving the debt increases rapidly. $\overline{Z}$ is the long-term average resource income describing the resource wealth of the country. The motivation behind such a formulation is to capture the wealth effect arising from resource ownership, in which, if the government owns higher resource wealth, the sustainability of its debt becomes stronger, and hence, it decreases the interest rate by playing a collateral role.

One common way of introducing a borrowing constraint is to explicitly place limits on borrowing as $B \leq \overline{B}(\overline{Z})$. In full-blown dynamic model settings, such a constraint would ensure an increase in the shadow price of borrowing, the closer the borrowing gets to its limit. In the two-period settings in this study, such a constraint would be binding and the borrowing amount would be predetermined. In order to study the impact of natural resources on the alleviation of the borrowing constraint, we explicitly introduce an increasing cost of borrowing.

The government maximizes 2-period utility by choosing the consumption in periods 0 and 1, and the borrowing in period 0. The aggregate utility function is given by:

$$U(C_0) + U(C_1) - f\left(\frac{PS_0}{T}\right)U(\overline{C}) \tag{2.4}$$

Here, $\overline{C}$ is the long-term average of consumption. In this formulation, the government's primary budget balance PS_0 enters into the utility through increasing convex function *f*, $f(0)=0$, $f'(\cdot)>0$ and $f''(\cdot)>0$. Formally, primary surplus is represented as:

$$PS_0 = T + Z_0 - C_0 \tag{2.5}$$

The last term in (2.4) implies that aggregate utility decreases with a higher primary budget balance. Then, function *f* is multiplied by average utility $U(\overline{C})$ in order to express this decrease in utility terms, which as a result causes the aggregate utility function to be homogenous. There is no explicit discounting appearing in the utility function. Nevertheless, there is implicit discounting going on through function *f*. As there is a utility "penalization" in the case of higher (lower) budget surplus, more (less) consumption in period 0 will be preferred.[10]

It is important to note that fiscal balance is represented as a ratio to *T*, which describes the size of the fiscal balance compared to a traditional economy and controls for the scale of the economy. Political pressure rises with *Z* and ceases with *T*, as *T* is collected as lump-sum taxes, whereas *Z* is an endowment. The convexity of the *f* function is directly related to the severity of the political pressures arising with the higher endowment shocks. If *f* is more convex, then the government has to cope with higher pressure and increase current consumption more to decrease the disutility.

Talvi and Vegh (2005) approach the pressure to spend coming from the primary surplus through the *f* function in two ways. First, they include it in the budget constraint as a fiscal rule. This leads to procyclicality of the current period consumption. Second,

[10] An interesting variation of the model with a slightly different utility function and discounting can be found in Appendix 2.E.

they claim that the pressure stemming from primary surplus can be modeled by including it in the utility function. In our model, we follow the second approach as our view is that, in most developing countries a spending increase in favorable times is not mainly due to the fiscal rules in place, but rather is due to ad hoc government actions to ease the pressure from interest groups through unlawful means, such as rent seeking and corruption.

Maximization of the government's objective (2.4) given (2.2), (2.3) and (2.5) with respect to *B* yields the following first-order condition:

$$U'(C_0) = U'(C_1)\left[R\left(\frac{B}{\overline{\overline{Z}}}\right) + \frac{B}{\overline{\overline{Z}}}R'\left(\frac{B}{\overline{\overline{Z}}}\right)\right] - \frac{1}{T}f'\left(\frac{PS_0}{T}\right)U(\overline{C}) \tag{2.6}$$

The Euler equation shows that consumption smoothing is disturbed and the government needs to address the disutility coming from saving the resource endowment for the next period by increasing the consumption in period 0. Also, as interest payments increase disproportionately with the increase of the debt amount, the choice of debt amount will differ from the one corresponding to perfectly smoothed consumption. The last term in (2.6) decreases the marginal utility of consumption in period 0 and thus corresponds to the higher level of consumption in the same period. On the other hand, the term $\left[R\left(\frac{B}{\overline{\overline{Z}}}\right) + \frac{B}{\overline{\overline{Z}}}R'\left(\frac{B}{\overline{\overline{Z}}}\right)\right]$ leads to higher marginal utility decreasing the consumption level in period 0.

From the first-order condition (2.6) it can be determined that debt amount *B* decreases with the increase of resource revenue Z_0, $-1 < \frac{dB}{dZ_0} < 0$.[11] From (2.2), we find

[11] For detailed derivation of the model equations, please refer to Appendix 2.C.

that current consumption increases with resource revenue but this increase is less than the resource revenue increase itself as future consumption also increases, $0 < \frac{dC_0}{dZ_0} = 1 + \frac{dB}{dZ_0} < 1$. In the current settings, procyclicality β would be defined as below indicating procyclical government consumption:

$$\beta = \frac{dC_0}{dZ_0}\frac{Z_0 + T}{C_0} > 0 \qquad (2.7)$$

We evaluate the model driven procyclicality at $Z_0 = Z_1 = \overline{Z}$, $\overline{\beta} = \left.\frac{dC_0}{dZ_0}\frac{Z_0 + T}{C_0}\right|_{Z_0 = \overline{Z}}$. Then, as there is no investment, the whole income is consumed, $C_0 = C_1 = \overline{C} = \overline{Z} + T$. We assume the utility function to be $U(C) = C^{\rho}$ where $0 < \rho < 1$, and denote $\overline{S} \equiv \frac{\overline{Z}}{\overline{C}}$ - as the share of resource income in total income. Clearly, $0 \le \overline{S} \le 1$. We then obtain the following formula for $\overline{\beta}$ which depends on $\overline{S}$:

$$\overline{\beta} \equiv \beta(\overline{S}) = \frac{\rho(1-\rho)\overline{S}(1-\overline{S})^2 + 2\rho R'(0)(1-\overline{S})^2 + f''(0)}{2\rho(1-\rho)\overline{S}(1-\overline{S})^2 + 2\rho R'(0)(1-\overline{S})^2 + f''(0)\overline{S}} \qquad (2.8)$$

Equation (2.8) is key to describing the relationship between resource richness and government consumption procyclicality. Below, we discuss important properties of this equation that are consistent with observations in the previous section. As noted, the evidence suggests that there is a U-shaped relationship between resource richness and procyclicality. It can be shown that under the current assumptions the function $\beta(\overline{S})$ has a unique internal extreme - $S*$, and that it is a minimum point in the interval $0 \le \overline{S} \le 1$, which we put as a separate proposition below. This fact gives rise to the U-shaped pattern of the function in the [0,1] region.

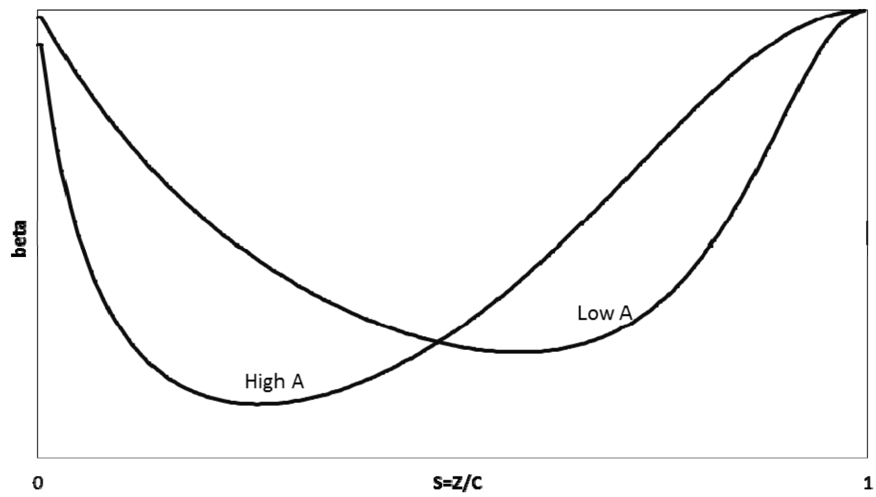
Proposition: *The function* $\beta(\bar{S})$ *as in (2.8) has a unique internal extreme in the [0,1] region and it is a minimum, given* $f''(0) > 0$, $R'(0) > 0$ and $0 < \rho < 1$.

Proof: see Appendix 2.D.

Below, we provide an illustration of the pattern that emerges from the model. The model incorporates two effects stemming from resource revenues: political economy problems represented by $f''(0)$, like rent-seeking or corruption, and borrowing constraint alleviation represented by $R'(0)$. As already mentioned, these effects are not independent of each other. Highly corrupt governments will likely face tighter borrowing constraints in the financial markets. In other words, the values of $f''(0)$ and $R'(0)$ are most probably positively correlated. To empirically support this claim, as mentioned earlier, there is a strong correlation between our political economy measure and the borrowing constraint measure. As Appendix 2.D shows, $A \equiv \frac{f''(0)}{\rho R'(0)}$ plays a central role in determining the minimum and the shape of the curvature. Hence, in the illustration of our model we make use of this observation, and elaborate on the comparative values of $f''(0)$ and $R'(0)$.

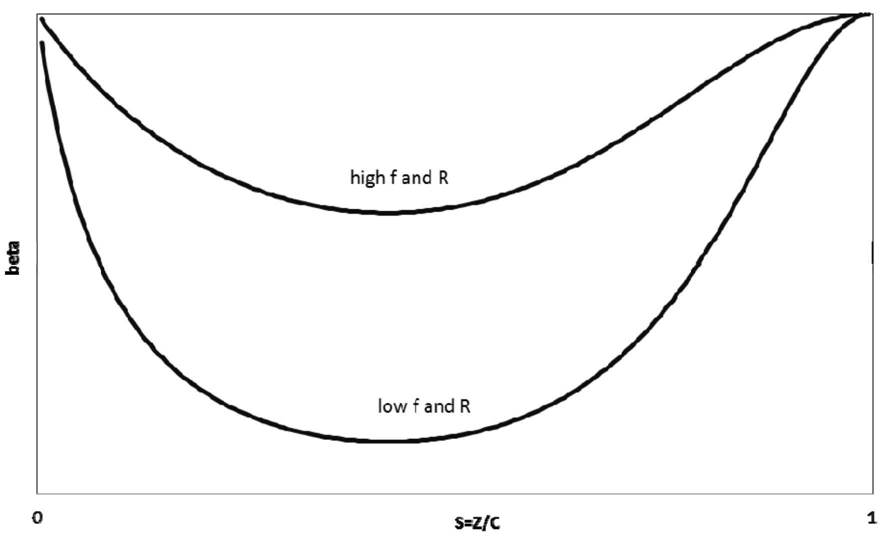
From Figure 2.7, we observe that with the increase of A the minimum of the curve moves leftwards closer to zero. Similarly, lower A is associated with the higher minimum that approaches the unit. With lower A, the borrowing constraint alleviation effect dominates the political economy effect for higher levels of resource richness.

Figure 2.7: Illustration of the model-driven U-shape at different levels of A



Although the ratio of $f''(0)$ and $R'(0)$ determines the location of the minimum, the level of the curve is determined by the values of $f''(0)$ and $R'(0)$. If we keep the ratio constant and increase the numerator and the denominator by the same multiplier then the U-curve will move upwards without changing the minimum, as shown in Figure 2.8.

Figure 2.8: Illustration of the model-driven U-shape for different $f''(0)$ & $R'(0)$ with the same minimum



2.5. Concluding remarks

In this paper, we analyzed fiscal policy procyclicality in resource-rich countries. For developing countries, we obtained a strong U-shaped relationship between the procyclicality of capital expenditures and the resource richness measure, i.e. the mineral exports share in total merchandise exports. The U-shaped pattern was robust for different methodologies and various checks. We considered two hypotheses that in combination can generate a U-shaped impact on procyclicality: first, the ***political economy hypothesis***, and second, the ***borrowing constraint hypothesis***. This motivated us to build the model in Section 2.4. We found empirical evidence that is consistent with both hypotheses.

Interestingly, when we look at OECD countries in Table 2.1, i.e. Group 3 and Group 4, we see that resource richness is associated with higher procyclicality, and that this is mainly due to capital expenditures. We noted in Section 2 that OECD countries do not face borrowing constraints and have strong institutional environments. This suggests that there may be a third reason why resource richness leads to higher procyclicality. One alternative hypothesis is that of ***revenue maximization***. When resource prices are high, the return on investment in the resource sector may also be very high, and a government may want to use the opportunity in the up-cycle to maximize its revenues. This would lead to higher capital expenditures by the government and consequently to higher output in the economy. Here, the government's behavior is similar to that of a profit-maximizing firm. Although plausible, we found no empirical support for this hypothesis in the available data. We obtained a procyclicality measure for the government expenditures on mining and mineral resources, manufacturing and construction using the method similar to equation (2.1). However, we found no pattern of dependence between the obtained measure and the resource richness measure. The revenue maximization hypothesis, therefore, is not supported by our data.

In order to illustrate the findings, we have built a model that generates the U-shaped effect combining political economy and borrowing constraint hypotheses. We have modeled political economy problems as the disutility from having a budget surplus. Under an imperfect institutional environment, high resource revenues (or budget surplus) create pressure on the government to increase spending. This leads to fiscal policy procyclicality. The borrowing constraint alleviation effect is modeled in so that resource ownership by the government creates a wealth effect. This signals the government's long-term debt sustainability and therefore alleviates the borrowing constraint.

Moreover, although we worked with multiple effects that generate a U-shaped pattern, we also explored the possibility of explaining the pattern with a single effect. Again, we found no reasonable hypothesis that can alone explain the U-shaped pattern. This study highlights the complexity of resource richness impact on fiscal policy procyclicality, and the implausibility of explaining the empirical U-shaped pattern with a single hypothesis. To the best of our knowledge, this is the first study to attempt to formalize the borrowing constraint alleviation hypothesis for resource-rich countries.

2.6. References

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2.7. Appendices

Appendix 2.A: Data description

Gross Domestic Product

The United Nations Statistical Division maintains the National Statistical Database that contains the main national account aggregates for 200 countries for the period starting from 1970. This is our source for current and constant price GDP in local currencies data. It allows us to derive the measure of economic growth and, using current and constant price GDP data, we obtain the GDP deflator. Later, this deflator is used to obtain constant price government expenditure data.

Resource richness

We use the annual mineral export and import data available from World Development Indicators (2009) from 1960 onwards. We add the two available measures– fuels exports and ores and metals exports as a share of total merchandise exports, and call it the mineral export share of total merchandise exports. Using the data, we derive our main measure of resource richness. We take the time series averages for 1961-2000, and obtain an average mineral export share as a share of total merchandise exports for each country (*min6100*). In addition, we refer to three other resource richness measures found in the literature; in Sachs and Warner (1997) and Sala-i-Martin, Doppelhofer and Miller (2004). These are:

- The share of exports of primary products in GNP in 1971 (*sxp*) and in 1980 (*sxp80*). Primary product exports are exports of fuel and non-fuel primary products. Non-fuel primary products correspond to SITC categories 0, 1, 2, 4 and 68. Fuels correspond to SITC category 3. These categories are from the Revision 1 of the SITC. Source: Sachs and Warner (1997).

- The share of mineral production in GNP in 1971. $SNR = \frac{M71*1000}{GNPD71*POP70}$, where M71 is the value of mineral production in 1971. This is calculated by Sachs and Warner (1997) from price and quantity data as: $M71_j = \sum_{j=1}^{23} p_i \cdot mq_{ij}$. The sum includes over 23 minerals.

- The fraction of GDP produced in the Mining and Quarrying sector. Data are for the year 1988 when possible, or the closest available year. Source: Sala-i-Martin et al (2004) taken from Hall and Jones (1999).

Government expenditures

Although for developing countries, government final consumption expenditures data are readily available in the national accounts tables by WDI or UN, due to measurement challenges the government investment data is missing from those tables. Government investment data for developing countries used in this study are from Easterly and Rebelo (1993), or more recent data from the Global Development Network Growth Database (GDN-GD) – Easterly database, covering 1970 to 2000. To analyze government expenditure data at the disaggregated level, we utilize the data from the

GDN-GD database. The GDN Growth Database is publicly available at: http://go.worldbank.org/ZSQKYFU6J0

Borrowing constraints

As a measure of the borrowing constraint, we refer to the ratings of government bonds issued by different rating agencies. Here, we use Foreign-Currency Government Bond Ratings issued by Moody's Investors Service. The ratings are as of September 2009, and "reflect the government's capacity and willingness to mobilize foreign exchange to repay its foreign-currency denominated bonds on a timely basis" (Moody's Investors Service 2006, http://www.moodys.com.br/brasil/pdf/SovGuide2006.pdf). We assign numerical values to the issued ratings between 1 and 19, 1 standing for the least constrained governments. More explicitly, AAA=1, AA1=2, AA2=3, AA3=4, A1=5, A2=6, A3=7, BAA1=8, BAA2=9, BAA3=10, BA1=11, BA2=12, BA3=13, B1=14, B2=15, B3=16, CAA1=17, CAA2=18 and CAA3=19.

Political economy measures

The source of political economy indicators are Control of Corruption and Government Effectiveness measures taken from the Worldwide Governance Indicators 1996-2008 by the World Bank. Control of Corruption (*CC960*8) captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. Government Effectiveness (*GE9608*) – captures perceptions of the quality of public services, quality of the civil service and the degree of its independence from political pressures, quality of policy formulation and implementation, and credibility of the government's commitment to such policies. Voice and Accountability – captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. Political stability – captures perceptions of the likelihood that a government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism.

Appendix 2.B: Robustness check

To obtain an alternative procyclicality measure, we run the log difference of real total government expenditures from its HP filtered level on the log-differenced real GDP gap.

$$\ln G_{it} - \ln G_{it}^{HP} = \delta_i + \beta_i[\ln Y_{it} - \ln Y_{it}^{HP}] + \varepsilon_{it} \tag{2.B.1}$$

In the equation above, the variables denoted by HP are Hodrick-Prescott filtered series. Along with the cyclicality measure for real total government expenditures (*beta_rtote_gap*), we obtain an alternative cyclicality measure for real government current (*beta_rcure_gap*) and capital expenditures (*beta_rcape_gap*). As we have done with our main procyclicality measure, in Table 2.7 and Figure 2.9-2.11 below we do the same exercise for the alternative measure and show that the U-shaped pattern persists for the alternative procyclicality measure.

Table 2.7: OLS regressions – Alternative government expenditures procyclicality measures vs. resource richness, for non-OECD countries that have at least 20 years of government expenditure data

	beta_rtote_gap		beta_rcure_gap		beta_rcape_gap	
MIN6100	-0,0012 (-0,23)	-0,0300 (-1,70)*	-0,0024 (-0,66)	-0,0122 (-0,91)	-0,0024 (-0,16)	-0,1521 (-3,11)***
MIN6100_2	-	0,0004 (1,70)*	-	0,0001 (0,76)	-	0,0019 (3,19)***
Adjusted R_squared	0,00	0,02	0,00	0,00	0,00	0,19
# of obs	38	38	37	37	36	36

t-stats are in the brackets under coefficients. Variables **MIN6100** – fuels and ores and metals exports share in total merchandise exports, **MIN6100_2** - the square of min6100.

Figure 2.9: Alternative total expenditures cyclicality measure in non-OECD countries – for countries that have at least 20 years of data

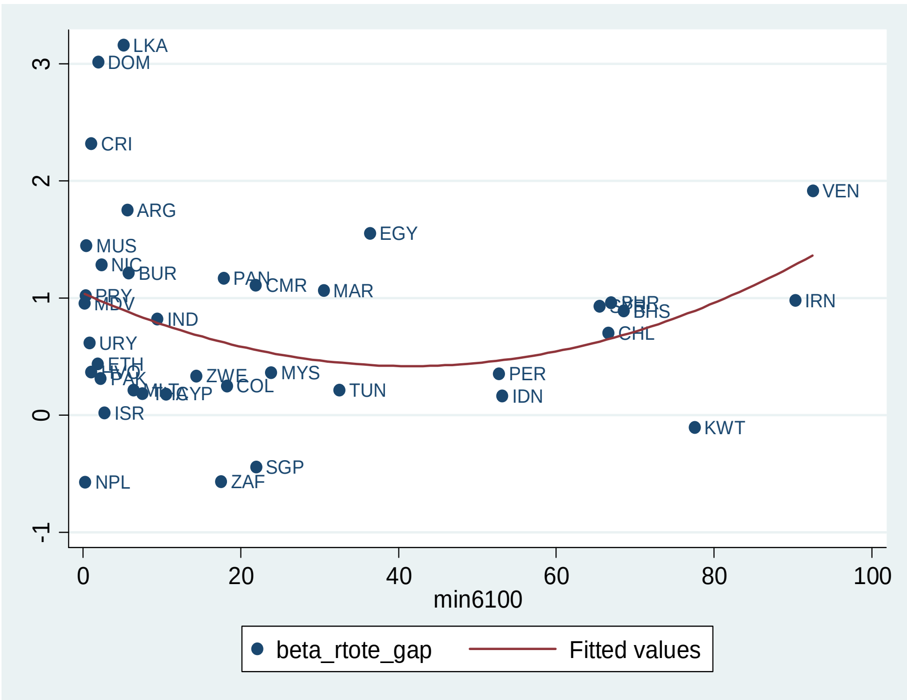


Figure 2.10: Alternative current expenditures cyclicality measure in non-OECD countries – for countries that have at least 20 years of data

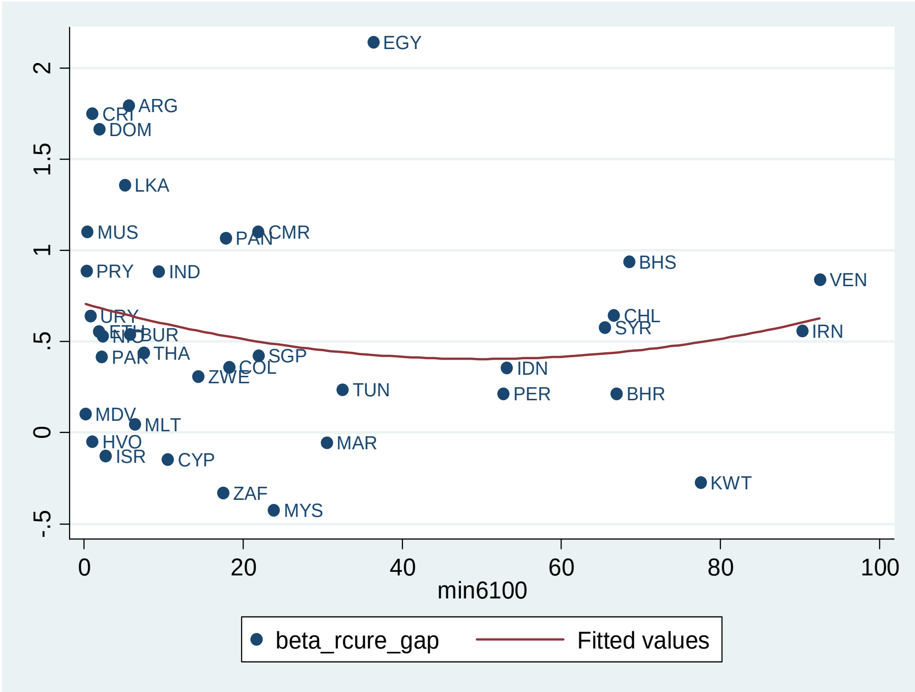
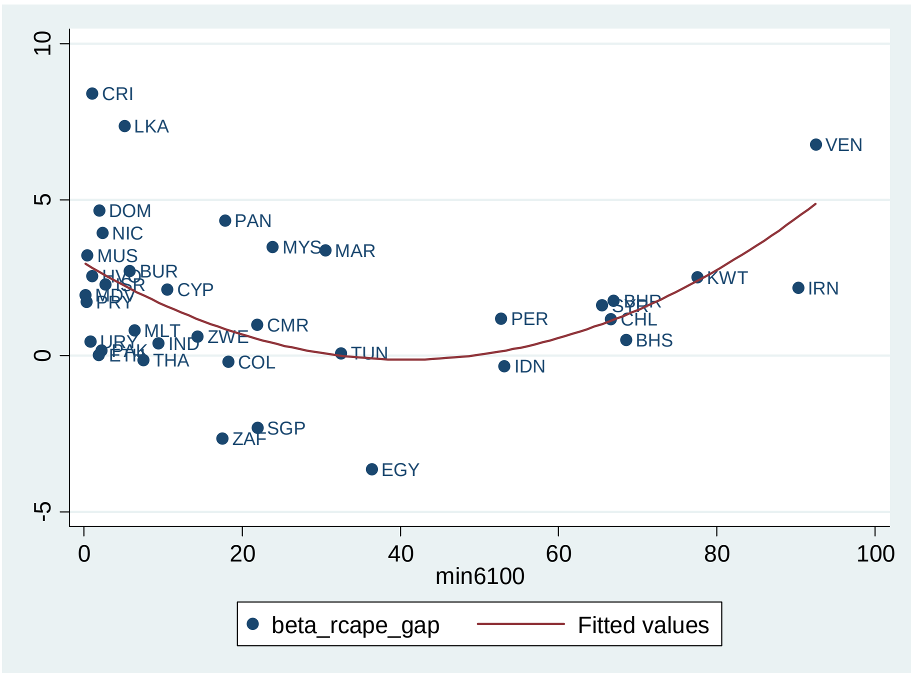


Figure 2.11: Alternative capital expenditures cyclicality measure in non-OECD countries – for countries that have at least 20 years of data



Appendix 2.C: Model details

F.O.C. for maximization problem (2.4) given (2.2), (2.3) and (2.5) is:

$$U'(C_0)=U'(C_1)\left[R\left(\frac{B}{\overline{Z}}\right)+\frac{B}{\overline{Z}}R'\left(\frac{B}{\overline{Z}}\right)\right]-\frac{1}{T}f'\left(\frac{-B}{T}\right)U\left(\overline{C}\right)$$

Using implicit function theorem:

$$\frac{dB}{dZ_0}=\frac{-U''(C_0)}{U''(C_0)+U''(C_1)\left[R\left(\frac{B}{\overline{Z}}\right)+\frac{B}{\overline{Z}}R'\left(\frac{B}{\overline{Z}}\right)\right]^2-U'(C_1)\left[\frac{2}{\overline{Z}}R'\left(\frac{B}{\overline{Z}}\right)+\frac{B}{\overline{Z}^2}R''\left(\frac{B}{\overline{Z}}\right)\right]-\frac{1}{T^2}f''\left(\frac{-B}{T}\right)U\left(\overline{C}\right)}<0$$

From (2) we have that $\frac{dC_0}{dZ_0}=1+\frac{dB}{dZ_0}$. Then:

$$\frac{dC_0}{dZ_0}=\frac{U''(C_1)\left[R\left(\frac{B}{\overline{Z}}\right)+\frac{B}{\overline{Z}}R'\left(\frac{B}{\overline{Z}}\right)\right]^2-U'(C_1)\left[\frac{2}{\overline{Z}}R'\left(\frac{B}{\overline{Z}}\right)+\frac{B}{\overline{Z}^2}R''\left(\frac{B}{\overline{Z}}\right)\right]-\frac{1}{T^2}f''\left(\frac{-B}{T}\right)U\left(\overline{C}\right)}{U''(C_0)+U''(C_1)\left[R\left(\frac{B}{\overline{Z}}\right)+\frac{B}{\overline{Z}}R'\left(\frac{B}{\overline{Z}}\right)\right]^2-U'(C_1)\left[\frac{2}{\overline{Z}}R'\left(\frac{B}{\overline{Z}}\right)+\frac{B}{\overline{Z}^2}R''\left(\frac{B}{\overline{Z}}\right)\right]-\frac{1}{T^2}f''\left(\frac{-B}{T}\right)U\left(\overline{C}\right)}>0$$

The model is evaluated at $Z_0=Z_1=\overline{Z}$. Then, $C_0=C_1=\overline{C}=\overline{Z}+T$

$$1>\overline{\beta}=\left.\frac{dC_0}{dZ_0}\frac{Z_0+T}{C_0}\right|_{Z_0=\overline{Z}}=\frac{U''\left(\overline{C}\right)-\frac{2R'(0)}{\overline{Z}}U'\left(\overline{C}\right)-\frac{1}{T^2}f''(0)U\left(\overline{C}\right)}{2U''\left(\overline{C}\right)-\frac{2R'(0)}{\overline{Z}}U'\left(\overline{C}\right)-\frac{1}{T^2}f''(0)U\left(\overline{C}\right)}>0$$

Assuming $U(C)=C^{\rho}$ and denoting $\overline{S}\equiv\frac{\overline{Z}}{\overline{C}}$ - the share of resource income in total income, obtains:

$$\overline{\beta}=\beta\left(\overline{S}\right)=1-\frac{\rho(1-\rho)\overline{S}\left(1-\overline{S}\right)^2}{2\rho(1-\rho)\overline{S}\left(1-\overline{S}\right)^2+2\rho R'(0)\left(1-\overline{S}\right)^2+f''(0)\overline{S}}$$

Solving $\frac{d\overline{\beta}}{d\overline{S}} = 0$ obtains the internal minimum point.

$$\frac{d\overline{\beta}}{d\overline{S}} = \frac{2\rho(1-\rho)\left[f''(0)\overline{S}^2(1-\overline{S}) - \rho R'(0)(1-\overline{S})^4\right]}{\left[2\rho(1-\rho)\overline{S}(1-\overline{S})^2 + 2\rho R'(0)(1-\overline{S})^2 + f''(0)\overline{S}\right]^2} = 0$$

Appendix 2.D: Proof of the proposition

First, it is necessary to show that for $\overline{S} \in [0,1]$ an internal minimum exists. We should find at least one solution for $\left.\frac{d\overline{\beta}}{d\overline{S}}\right|_{\overline{S}=S^*} = 0$ which will be a local minimum. To do so, we take the first derivative of the function $\beta(\overline{S})$ and equalize it to zero. It yields:

$$A \cdot S^{*2} - (1 - S^*)^3 = 0 \qquad (2.C.1)$$

where for simplicity in notation $A \equiv \frac{f''(0)}{\rho R'(0)} \geq 0$ and $0 \leq S^* \leq 1$.

(C.1) can be written as:

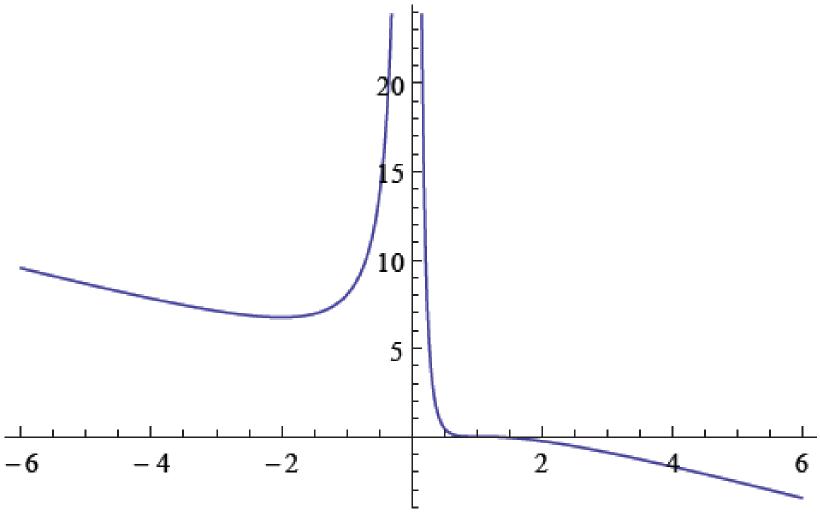
$$S^{*3} + (A-3)S^{*2} + 3S^* - 1 = 0 \qquad (2.C.2)$$

From the properties of the cubic equation we know that it has at least one real root. Using the implicit function formula we show that in the interval between 0 and 1, S* decreases with A:

$$\frac{dS^*}{dA} = -\frac{S^{*2}}{3S^{*2} + 2(A-3)S^* + 3} < 0$$

To explore further we will use graphical analysis. Figure 2.12 below plots S* and A relationship without any restrictions, S* being the x-axis and A being the y-axis.

Figure 2.12: Relationship between A (y-axis) and S* (x-axis)



From the graphical analysis, as well as from the analysis of the determinant of (2.C.2), we have the following results:

1) If $0 \le A < \frac{27}{4}$, then there is a unique $S^* \in (0,1]$ solving (2.C.2).

2) If $A > \frac{27}{4}$, then there are three S* solving (2.C.2). One of them is in the interval $(0,1]$ and the other two are negative.

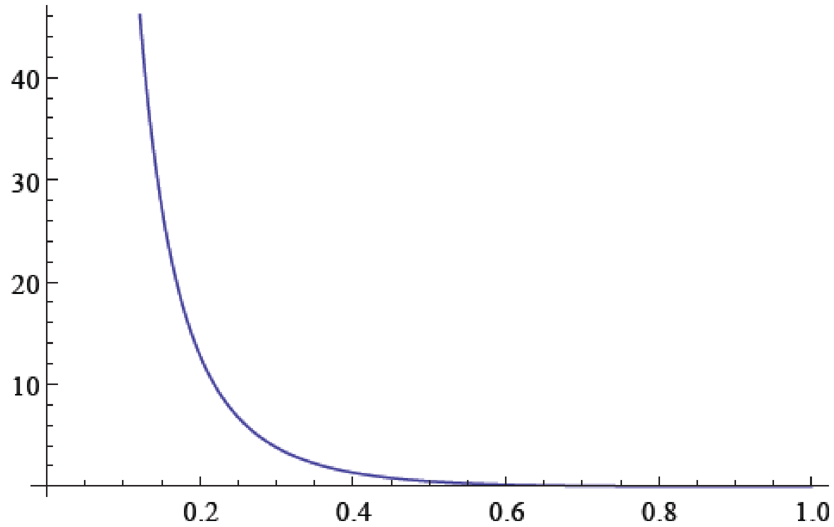
3) If $A = \frac{27}{4}$, then there are two S* solving (2.C.2); One of them is in the interval $(0,1]$ and the other is negative.

4) $A < 0$ is not attainable with the current settings.

From the results above it is clear that there is always S* for any A>0 solving (2.C.2) and it is unique in the interval of our interest $(0,1]$. Figure 2.13 exhibits this clearly by zooming in Figure 2.12 for the $(0,1]$ interval. This can be interpreted so that for any values of $f''(0)$ and $R'(0)$ the function $\beta(\bar{S})$ as in (2.8) has a unique extreme point.

To show that it is a minimum, we pursue a simple numerical check. Here, if we show one example that this is a minimum this will be sufficient to claim that it is true in general. Let us assume $f''(0)=0.01$, $R'(0)=0.01$ and $\rho=0.9$. Then, $S^*=0.42$ and $\beta(S^*)=0.64368$. Any values of S* different from 0.42 should yield higher β. In our case, $\beta(0.40)=0.64395$ and $\beta(0.44)=0.64398$ that are higher than $\beta(0.42)$. Hence, S* is the minimum.

Figure 2.13: Relationship between A (y-axis) and minimum S* (x-axis) for $S^* \in (0,1]$



Appendix 2.E: Model variation

In contrast to (2.4) we now examine the aggregate utility function in the following form subject to (2.2), (2.3) and (2.5):

$$U(C_0)+U(C_1)-f\left(\frac{PS_0}{T}\right)U(C_1)=U(C_0)+\left[1-f\left(\frac{PS_0}{T}\right)\right]U(C_1)$$

The term $\left[1-f\left(\frac{PS_0}{T}\right)\right]$ can be viewed as a discounting. In case of no budget surplus the discounting term becomes 1. The necessary assumption here is that $1-f\left(\frac{PS_0}{T}\right)>0$ to treat it as a discounting term. This is similar to Caselli and Cunningham (2009) as they view it as a probability of surviving for the next period.

It yields the Euler equation as follows:

$$U'(C_0)=U'(C_1)\left[R\left(\frac{B}{\overline{Z}}\right)+\frac{B}{\overline{Z}}R'\left(\frac{B}{\overline{Z}}\right)\right]\left[1-f\left(\frac{PS_0}{T}\right)\right]-\frac{1}{T}f'\left(\frac{PS_0}{T}\right)U(C_1)$$

Using the implicit function theorem:

$$\frac{dB}{dZ_0}=\frac{-U''(C_0)}{U''(C_0)+\left[1-f\left(\frac{PS_0}{T}\right)\right]\left\{U''(C_1)\left[R\left(\frac{B}{\overline{Z}}\right)+\frac{B}{\overline{Z}}R'\left(\frac{B}{\overline{Z}}\right)\right]^2-U'(C_1)\left[\frac{2}{\overline{Z}}R'\left(\frac{B}{\overline{Z}}\right)+\frac{B}{\overline{Z}^2}R''\left(\frac{B}{\overline{Z}}\right)\right]\right\}-\frac{1}{T^2}f''\left(\frac{PS_0}{T}\right)U(C_1)}<0$$

Clearly, $-1<\frac{dB}{dZ_0}<0$. Also, we have that $\frac{dC_0}{dZ_0}=1+\frac{dB}{dZ_0}$. Then:

$$\frac{dC_0}{dZ_0}=\frac{\left[1-f\left(\frac{PS_0}{T}\right)\right]\left\{U''(C_1)\left[R\left(\frac{B}{\overline{Z}}\right)+\frac{B}{\overline{Z}}R'\left(\frac{B}{\overline{Z}}\right)\right]^2-U'(C_1)\left[\frac{2}{\overline{Z}}R'\left(\frac{B}{\overline{Z}}\right)+\frac{B}{\overline{Z}^2}R''\left(\frac{B}{\overline{Z}}\right)\right]\right\}-\frac{1}{T^2}f''\left(\frac{PS_0}{T}\right)U(C_1)}{U''(C_0)+\left[1-f\left(\frac{PS_0}{T}\right)\right]\left\{U''(C_1)\left[R\left(\frac{B}{\overline{Z}}\right)+\frac{B}{\overline{Z}}R'\left(\frac{B}{\overline{Z}}\right)\right]^2-U'(C_1)\left[\frac{2}{\overline{Z}}R'\left(\frac{B}{\overline{Z}}\right)+\frac{B}{\overline{Z}^2}R''\left(\frac{B}{\overline{Z}}\right)\right]\right\}-\frac{1}{T^2}f''\left(\frac{PS_0}{T}\right)U(C_1)}>0$$

The equation above is evaluated at $Z_0=Z_1=\overline{Z}$. Then, $C_0=C_1=\overline{C}=\overline{Z}+T$. We obtain:

$$1>\overline{\beta}=\frac{dC_0}{dZ_0}\frac{Z_0+T}{C_0}\bigg|_{Z_0=\overline{Z}}=\frac{U''(\overline{C})-\frac{2R'(0)}{\overline{Z}}U'(\overline{C})-\frac{1}{T^2}f''(0)U(\overline{C})}{2U''(\overline{C})-\frac{2R'(0)}{\overline{Z}}U'(\overline{C})-\frac{1}{T^2}f''(0)U(\overline{C})}>0$$

The result is the same as for the model in the text. Hence, the consequential analysis applies, yielding a U-shaped relationship between procyclicality and resource richness.

Chapter 3

Has Azerbaijan Been Able to Use Its Natural Resources to Outperform Its Neighbors?

3.1. Motivation

The previous two chapters consider different aspects of the natural resource impact. With those findings in mind, this chapter considers the special case of Azerbaijan, which is an oil and gas rich country. By focusing on a specific country case, we will check whether we are able to apply the findings of the previous two chapters in a pratical way. For comparison, we will consider Azerbaijan's growth and fiscal performance as it relates to those of Armenia and Georgia. First, in light of findings in Chapter 1, assuming geographical, cultural and political proximity of these three South Caucasian countries, we look at the performance of their relative GDP. Then, we also analyze the cyclicality of fiscal policy in these countries in connection to Chapter 2.

The chapter is organized as follows: first, in Section 3.2, we provide background information about Azerbaijan and its oil sector. Section 3.3 contains the analysis of income and fiscal performances in separate subsections. Section 3.4 concludes.

3.2. Oil and Azerbaijan

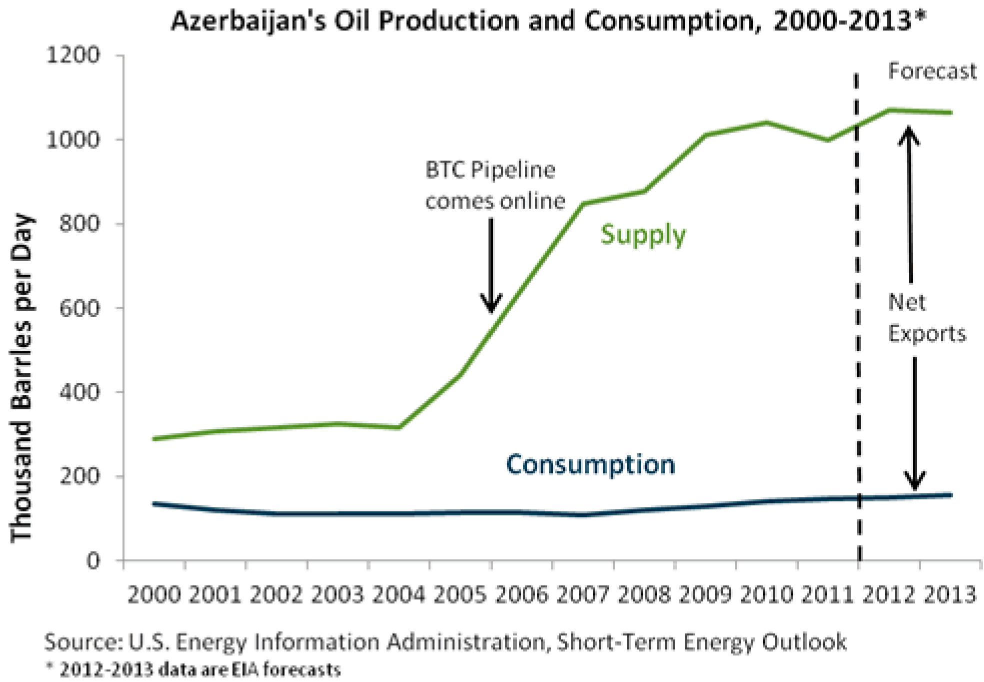
This chapter aims to answer the question whether the Azeri economy has been affected by the „resource curse“. We investigate whether oil rich Azerbaijan has outperformed other similar countries that have no natural resources, by comparing Azerbaijan with its immediate neighbors, Armenia and Georgia which are resource poor. I analyze the series of per capita income gaps between Azerbaijan and its neighbors Armenia and Georgia along with the fiscal policy procyclicality and other development indicators.

Azerbaijan had been extracting oil for the last century, and after gaining its independence from the Soviet Union in the early 1990s, it has been able to directly benefit from its large oil revenues. During the Soviet times, all the resource revenues were being collected and managed by the central government in Moscow, which allocated these oil revenues equally among member countries. Hence, Azerbaijan's economy was not affected by significant oil income. With independence, new challenges including improved management of oil wealth appeared on the agenda. A significant amount of oil extraction and exports started in 2004-2005. Managing its oil riches appropriately may bring Azerbaijan faster economic development and a "bright" future. On the other hand, as in case of many "unsuccessful" countries, a failure to use its riches efficiently may lead to severe economic and political consequences in the long term. Therefore, considerations of a potential negative resource impact are important for the economic future of the country.

In the early years of independence, with the collapse of the USSR, all manufacturing industries, including the oil industry, experienced deep reductions in production. As a leading industry in the country, the oil industry needed new investments to build its capacity and to bring in new technology. In 1999, the Contract of the Century was signed with different foreign oil multinationals, which has led to the modernization of the industry and to increased oil production, as shown in Figure 3.1.

From 1999 to 2004 oil production increased at a slower pace. Oil production in 1999 was close to 300 thousand barrels per day. By the end of 2005, the major investment projects in the oil fields started to yield results, and the vital newly-built oil exporting route Baku-Tbilisi-Ceyhan opened. Oil production and exports have increased significantly, reaching approximately one million barrels per day today.

Figure 3.1: Azerbaijan's Oil Production



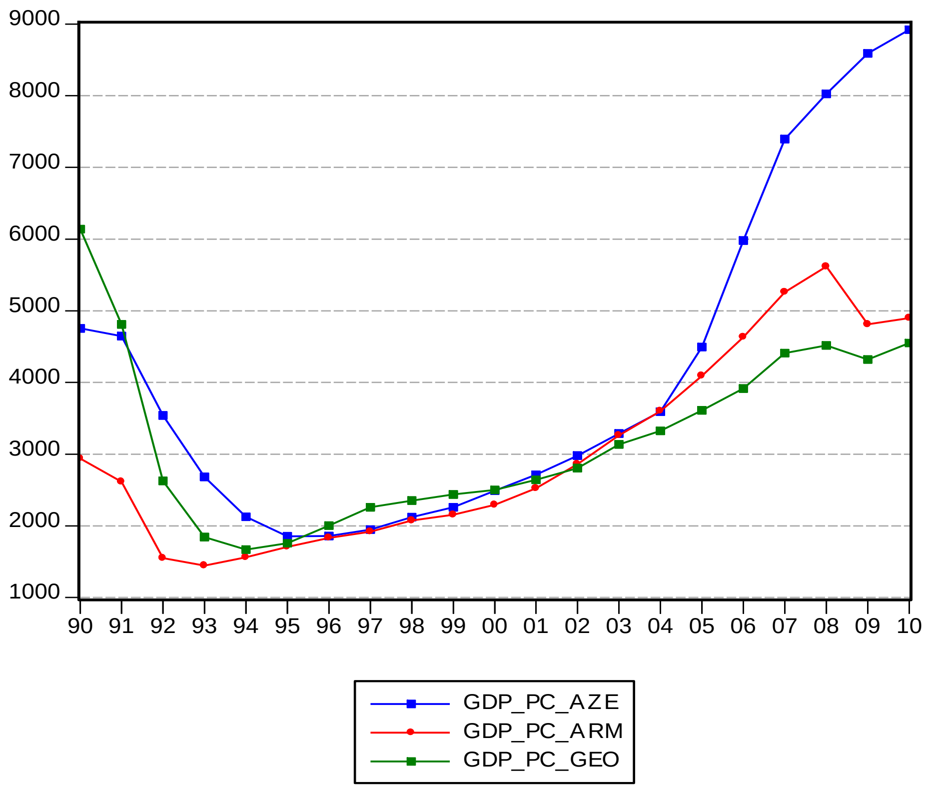
3.3. Performance comparison

3.3.1. Income performance

It is logical that significant increases in oil production and exports would lead to increases in the national income. However, as the literature argues, increased resource production creates Dutch Disease effect, which can depress other non-resource sectors of the economy. Moreover, there are political economy factors under the resource curse hypothesis that could further negatively impact the income of the population through rent-seeking and corrupt behaviors. As a result, increased resource production is not necessarily reflected in the income of population.

Figure 3.2 pictures PPP adjusted GDP per capita series during 1990-2010 periods. Up to 1995, the GDP declined; Azerbaijan lost almost half of its GDP compared to its level prior to 1990.

Figure 3.2: Purchasing Power Parity adjusted GDP per capita (constant 2005 international $), 1990-2010



As a transition country, Azerbaijan needed foreign investment and modern technology in order to restructure the economy. After such a decline in GDP, it was expected that the economy would start catching up to the previous levels of GDP, as was the case with other newly independent economies. Therefore, in order to understand the role of the natural resources in economic development it would be appropriate to compare Azerbaijan with similar economies that are resource poor. The natural comparison for that are its immediate neighbors: Armenia and Georgia. Armenia and Georgia provide a benchmark for resource poor economies and can help us to estimate the impact of oil in Azeri economic development. These three countries are of comparatively similar size with very close economic, ethnic and cultural ties. It can be seen from the graph that in 2010, Azerbaijan's GDP per capita was almost twice as high as in Armenia and Georgia.

Table 3.1 shows purchasing power parity adjusted GDP for these countries, which endured a significant economic downturn in early 1990's. In 1995, the South Caucasian countries had identical per capita income levels. After 1995, their economies started to grow at almost identical rates. Moreover, their PPP adjusted per capita GDP levels were almost identical during 1995-2004. However, starting from 2005, due to its high oil production volumes, the income gap began to widen between Azerbaijan and its neighbors. 2005 can be identified as the structural break year.

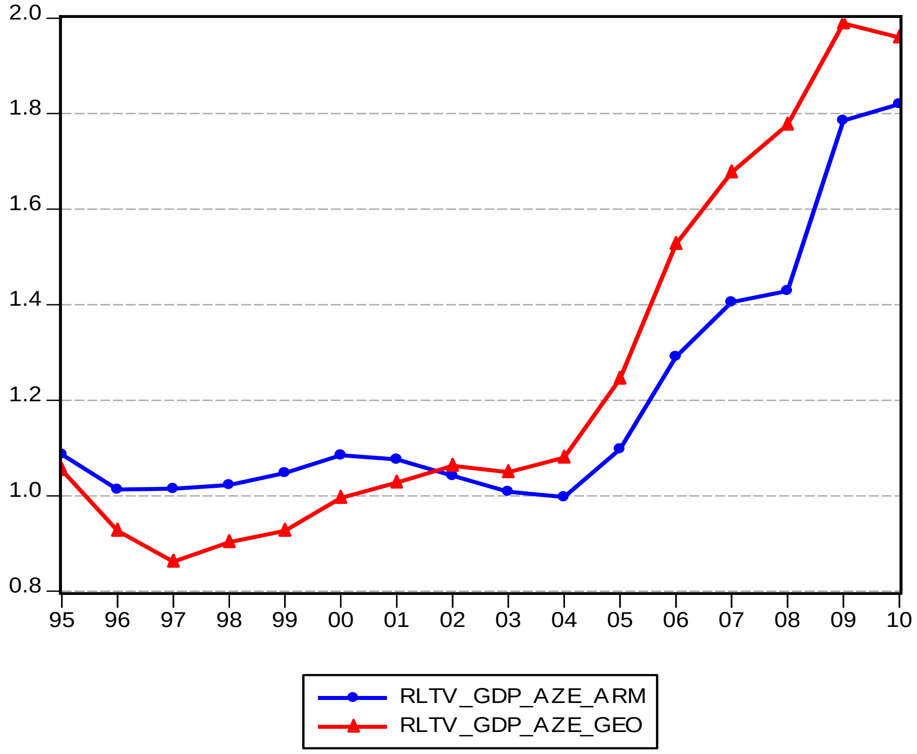
Table 3.1: PPP adjusted GDP per capita (constant 2005 international $) average annual growth rates

Period	Azerbaijan	Armenia	Georgia
1990-1995	-16,8%	-8,2%	-20,2%
1995-2004	7,7%	8,7%	7,4%
2004-2010	16,9%	5,8%	5,5%

To confirm that 2005 was indeed the break year, I perform a statistical test. If a structural break date in the time series of income differences exists, which coincides with the starting date of significant oil production, then I could claim that Azerbaijan has been successful in avoiding the negative effects of resource abundance thus far. If a structural break year is given exogenously, then a simple Chow Breakpoint Test can be applied to evaluate the statistical significance of the suggested break date. In the case of Azerbaijan, the suggested break date is 2005. In order to single out the structural break year related to resource production and to separate it from other non-resource structural changes, we need to compare Azerbijan to non-resource benchmark cases: Armenia and Georgia. We find relative GDP per capita series, as shown in Figure 3.3, and perform Chow's Breakpoint Test on the obtained series.

From the graph it can be seen that there is no clearly visible trend during 1995-2004, whereas starting from 2005 till 2010, both series contain a steep upward trend, as Azerbaijan started to outperform Armenia and Georgia in GDP per capita. By performing Chow's Breakpoint Test with known structural change date on both of these series with the year 2005 as the break date, we obtain F-statistics equal to 48 with respect to Armenia and to 66 with respect to Georgia, which allow us to reject the null hypothesis of no break date at less than 1% statistical significance level for both cases, confirming 2005 as the structural break year in this case.

Figure 3.3: Relative annual GDP performance: Azerbaijan vs. Armenia, Azerbaijan vs. Georgia

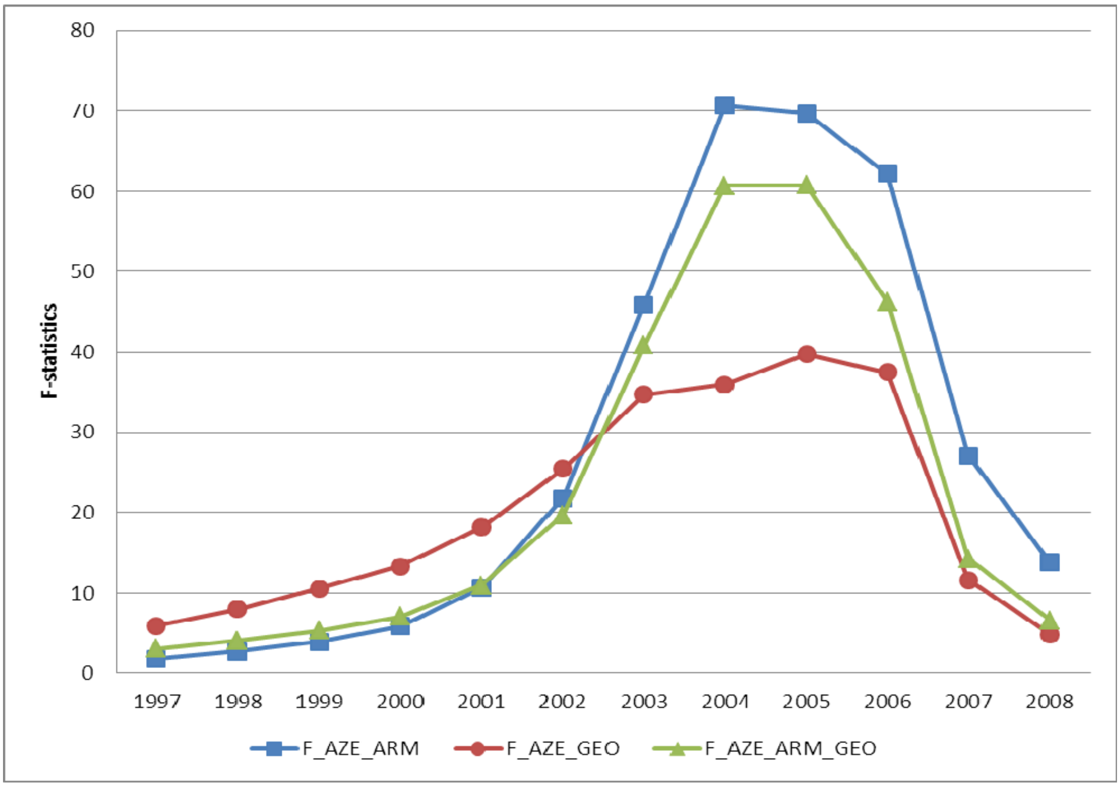


Source: World Development Indicators and author's calculations

Although, 2005 was designated as a structural break year, arguably, we can also search for an unknown structural change date using relevant tests. Therefore, we perform a Quandt-Andrews Test with unknown structural change date. Different from the Chow Breakpoint Test, this test does not presume any date. Instead it chooses the year as the structural break date where F-statistics reach the maximum value. Sometimes in the literature it is referred as SupF Test. When performing the Test on the annual per capita GDP of Azerbaijan alone, we obtain 2006 as the structural break year. However, as already noted, a more appropriate way of obtaining a structural break date is to look into the relative GDP series within the region. According to the Quandt-Andrews Test, the structural break date for the relative GDP series with respect to Georgia is 2005, and for the relative GDP series with respect to Armenia is 2004. If we take the relative GDP series of Azerbaijan with respect to the average of GDP for Armenia and Georgia, then the structural break year is again 2005.

It is important to note that in all of these cases, the F-statistics for 2004 and 2005 have very close values. For each year we compute F-statistics as in the Chow Breakpoint Test, shown in Figure 3.4. As can be seen, it reaches its maximum during 2004-2005 period, compared to both "control" countries' (F_AZE_ARM and F_AZE_GEO) and their average (F_AZE_ARM_GEO).

Figure 3.4: Results of the Chow Breakpoint Test: obtained F-statistics for SupF Test

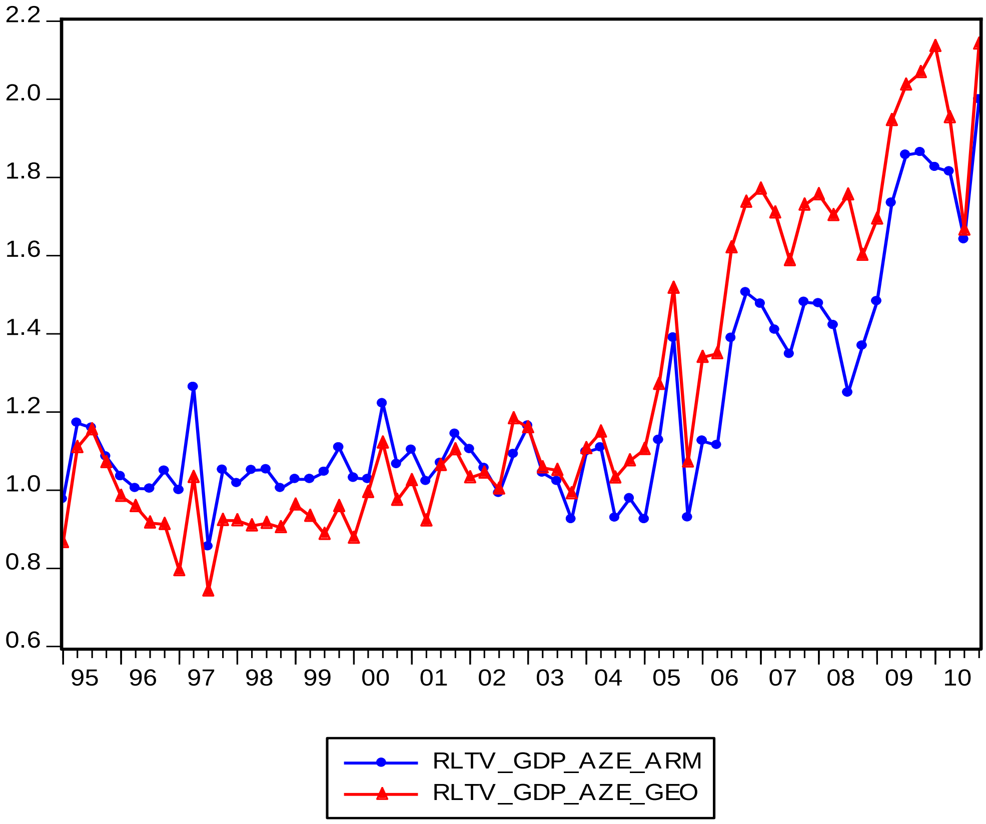


We have also obtained quarterly GDP series from International Financial Statistics database to check whether we could get similar conclusions with more frequent data[12]. With the quarterly data, we come to similar conclusions. Figure 3.5 shows that relative GDP per capita series fluctuate close to unit without clear trends. However, from 2005

[12] Quarterly GDP series for Azerbaijan were not complete in IFS database. Hence, we partially used the data provided by Azerbaijani Statistical Office.

onwards, the GDP per capita of Azerbaijan started to outperform those of Armenia and Georgia.

Figure 3.5: Relative quarterly GDP performance: Azerbaijan vs. Armenia, Azerbaijan vs. Georgia



Source: International Financial Statistics, World Development Indicators and author's calculations

Although we confirm that the year 2005 was a structural break year and this coincides with the significant oil production start date, one could argue that it was not due to oil production at all. Brunnschweiler's 2009 study of the former Soviet Union and Balkan transition countries finds that natural resources have contributed to post-transition growth. To check that, indeed, oil played a positive role in development and growth we follow the same methodology as Brunnschweiler (2009) .

$$G_{it} = \alpha_1 + \alpha_2 R_{it} + \alpha_3 X_{it} + \alpha_4 IC_{it} + \omega_i + u_{it}$$

In the above equation, G is annual per capita GDP growth rate; R is a resource richness measure; X denotes time-variant covariates; IC is a measure capturing initial conditions. Similar to Brunnschweiler (2009), we run the above regression on panel data for South Caucasian countries covering the post-transition period 1990-2010 leading to results shown in Table 3.2 below[13].

Table 3.2: Natural resources and growth - random effect estimation

	(1)	(2)
Oilprodpc	2.2129 (4.37)***	-
Fuelexp	-	0.0016 (2.38)**
Inf	-0.0007 (-0.97)	0.0018 (1.39)
Avgprivat	0.0828 (4.57)***	0.0608 (1.61)
Privatspeed	0.4303 (2.29)**	0.1555 (0.80)
Initial	-0.0928 (-1.17)	-0.1004 (-1.29)
R-squared within	0.59	0.12
R-squared between	0.09	1.00
R-squared overal	0.58	0.19
# of observations	57	43

z-statistics are in brackets

In column (1) of the table, we see that per capita oil production (oilprodpc), taken as a resource richness measure, has a positive impact on per capita GDP growth. As in Brunnschweiler (2009), we choose time-variant covariates including privatization level (avgprivate), privatization speed (privatspeed) and inflation (inf). It can be seen that privatization level and speed coefficients both have a positive sign. Inflation has a negative impact, albeit it is not statistically significant. Consistent with the growth

[13] Detailed data description can be found in the Appendix

literature predictions, GDP per capita in 1990 (initial), taken as an initial condition measure, has a negative impact, although it is also not statistically significant.

In column (2), we repeat the same regression with an alternative resource richness measure – fuel exports as a percentage of total merchandise exports. The impact of this measure remains positive and statistically significant. Other variables of the regression become statistically insignificant. Overall, this helps us to conclude that indeed resources had a positive effect on per capita growth rates.

3.3.2. Fiscal procyclicality

We also look at the nature of fiscal policy in Azerbaijan, Armenia and Georgia. To find a fiscal policy procyclicality measure, we follow the methodology laid out in Chapter 2. As the fiscal indicator to estimate the procyclicality we use government final consumption expenditures from the World Development Indicators by the World Bank, as this was the only measure in which we could find data for a sufficiently long period. The results are in Table 3.3. From the table, it is difficult to say whether the fiscal policy in Azerbaijan has been more procyclical compared to Armenia and Georgia.

As noted in Chapter 2, we consider two hypothesis affecting fiscal procyclicality based on borrowing constraint and political-economy factors. As argued, resource richness by providing extra foreign exchange earnings may alleviate borrowing constraints faced in global financial markets. Table 3.3. shows that indeed oil-rich Azerbaijan has better ratings than resource poor Armenia and Georgia, and this is consistent across all main rating agencies, conforming with the hypothesis.

The second hypothesis was that resource richness may intensify institutional problems. Institutional quality measures from Worldwide Governance Indicators displayed in the table below show Azerbaijan lags behind Armenia and Georgia in institutional quality. This observation is also in line with our findings in the previous chapter.

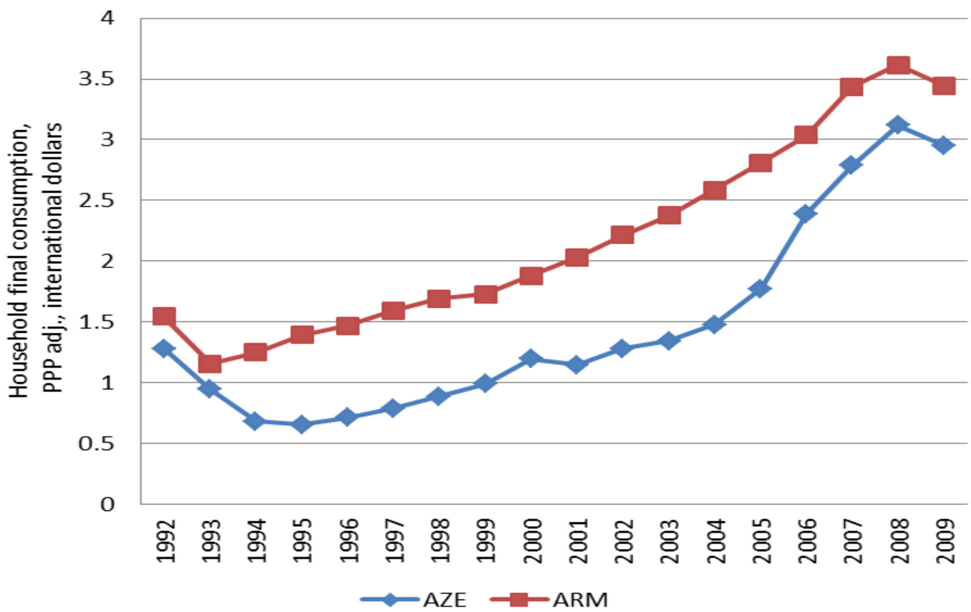
Table 3.3: Fiscal procyclicality in Azerbaijan, Armenia and Georgia, and its likely determinants

Indicators	**Azerbaijan**	**Armenia**	**Georgia**
Fiscal procyclicality, 1991-2011	0.89	0.66	0.82
Fiscal procyclicality, 2004-2011	0.81	0.17	2.06
Moody's government bond ratings, Febryary 2013	BAA3	BA2	BA3
Fitch government bond ratings, March 2013	BBB-	BB-	B+
Standard & Poor's government bond ratings, May 2013	BBB-	Not rated	BB-
Voice and Accountability, 1996-2011	-1.13	-0.66	-0.27
Political Stability, 1996-2011	-0.81	-0.19	-1.04
Government Effectiveness, 1996-2011	-0.81	-0.25	-0.23
Regulatory Quality, 1996-2011	-0.60	0.12	-0.15
Rule of Law, 1996-2011	-0.89	-0.42	-0.71
Control of Corruption, 1996-2011	-1.08	-0.62	-0.52

3.3.3. Performance of other development indicators

Presumably, the vast increase in GDP over the last several years was created by high exports of natural resources. So, it is an increase driven by foreign demand. An important question is whether domestic demand has played also a role. Therefore, we look at the performance of consumption also in comparison with the neighboring countries. Figure 3.6 depicts the purchasing power parity adjusted household final consumption in per capita terms for Azerbaijan and Armenia available in the World Development Indicators database by the World Bank.

Figure 3.6: Relative quarterly household final consumption performance: Azerbaijan vs. Armenia



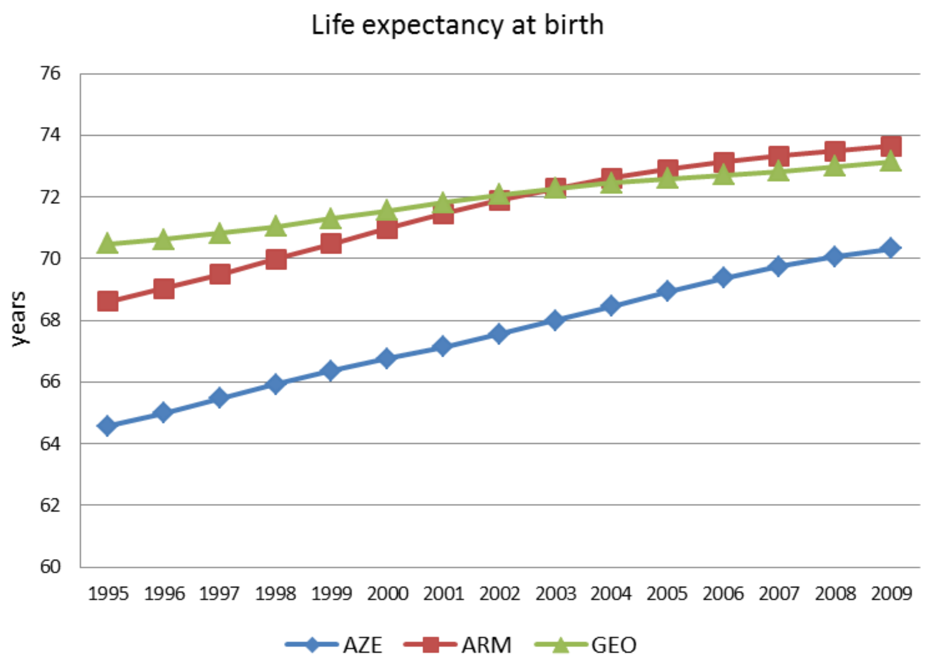
We consider other economic and development indicators to compare the performances of the three South Caucasian countries. Income equality measure, the so called GINI index, is another important indicator of socio-economic development. The GINI index is used to reveal the extent to which income distribution deviates from a perfectly equal distribution. It varies between 0 and 100, 0 being perfect equality and 100 being perfect inequality. In Azerbaijan, between 2001 and 2008, the GINI coefficient declined from about 37 to 34, indicating improvement in equality of income distribution.[14] The income share held by the poorest 40% of population has increased slightly from 19% to 20%, whereas the share of income held by the richest 40% has declined from 66% to 64%.

[14] The data for the GINI index is taken from World Development Indicators published by the World Bank; for Azerbaijan, there are 3 observations available, for 1995, 2001 and 2008.

Despite improvements in the equality of income distribution, Azerbaijan was not the leader in the region in this respect. The best performer among South Caucasian countries was Armenia, where the GINI index declined by 5 points to 31. During the same period, the GINI index did not change significantly in Georgia, remaining around 41. Overall, this may indicate that in light of significant oil revenues, Azerbaijan so far has not failed in the area of income distribution.

For the South Caucasian countries, life expectancy at birth has been increasing constantly since the early 1990s', as shown in Figure 3.7. It can be seen that the life expectancy trend is stable and steeper in Azerbaijan compare to its neighbors. Life expectancy in Armenia and Georgia is higher, showing convergence to 74, but in Azerbaijan it continues to grow despite the fact that it is still comparatively lower.

Figure 3.7: Life expectancy at birth in the South Caucasian region



Source: World Development Indicators

3.4. Concluding remarks

The data show that there is a favorable increasing per capita income gap in Azerbaijan. The existence of such a gap reveals the importance of oil in its overall development. It seems evident that, using its oil wealth, Azerbaijan has managed to outperform its South Caucasian neighbors since 2005. However, it is becoming a challenge for Azerbaijan to remain in this faster development path, as Aliyev (2011) argues that during an oil boom outperformance of oil rich countries compared to similar oil poor countries continues up to 10 years. It cannot remain on an over performing path forever. Within the next few years the growth of Azerbaijani GDP will likely converge back to the levels of GDP growth rates of its neighbors. Further, Azerbaijan should be mindful that political pressures on spending significant resource revenues could increase its fiscal procyclicality and destabilize the economy in the future.

3.5. References

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3.6. Appendix: Data description

Per capita GDP growth rates were taken from the World Development Indicators (WDI) database.

oilprodpc – total oil supply, thousand barrels per day, taken from U.S. Energy Information Administration database.

fuelexp – fuel exports as a percentage of total merchandise exports, taken from World Development Indicators database.

inf – inflation, GDP deflator, annual %, , taken from World Development Indicators database.

avgprivat – yearly average of large and small scale privatization measures obtained from EBRD Transition Report database.

privatspeed – the speed of privatization, calculated for year t as [avgprivat(t) – avgprivat(0)]/t.

initial – log of per capita GDP in USD in 1990.