UNDERSTANDING THE RESOURCE IMPACT USING MATCHING

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UNDERSTANDING THE RESOURCE IMPACT USING MATCHING*

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Abstract

We investigate the resource impact on economic growth using matching. Using a non-parametric minimum-distance matching method, we match the countries according to their observable characteristics, and estimate the relative growth rates of each matched pair. This way we are able to analyze the impact of the resources on relative growth rates, rather than on absolute growth rates as it has been done in the literature. Assuming 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. We use 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 relative exhaustible resource abundance and relative economic growth. For non-exhaustible resources, the results are mixed, with often a positive impact on relative growth. We discuss the contrary evidence in Sala-i-Martin et al. (2004) and highlight the differences in methodology and estimation that potentially may create differences in the results.

Keywords: resource-rich countries, minimum-distance matching, relative GDP growth, relative resource richness impact, omitted variable bias

JEL Classification: C14, O11, O13, O47, Q32

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Abstrakt

Tento článek 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. V článku 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.

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 some kind of curse which in the longrun 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).

Along with the supporters of the resource curse phenomenon, there is much literature that argues against it. In most of the 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.

In this research, we also analyze the resource impact on economic growth. 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, but not on absolute growth rates as has been done in the literature. This will allow us to estimate the under- or over-performance of the country depending on how relatively resource abundant it is. Matching has an advantage over fixed-effect estimation, as differencing is performed between countries, but not according to time.

One of the main challenges here is to find a match for each resource-rich country. Here, we use 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 in mining 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 into 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 our 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 us to control for more variables and to single out the direct effect of the resource abundance variable. Also, we plan to use different measures of resource abundance.

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 for the robust negative relationship between resources and growth using an econometric approach. They name this phenomenon the "Resource Curse". The existence of such "unexpected" empirical evidence has been a motivation for the literature.

Sachs and Warner 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 stays significant after controlling for different variables found in earlier growth literature.[1]

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: 1) the share of mineral production in GDP; 2) the fraction of primary exports in total exports; and 3) the log 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 such 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 additional 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 the resource curse. The evidence clearly supports the results of SW.

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

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

There is much literature that argue against the results of SW work and the existence of the resource curse phenomenon. Most of these critiques are concentrated on the estimation methodology of the cross-country regressions used in SW. Namely, omitted variable bias and endogeneity issues are crucial ones that need to be addressed when estimating cross-country regressions.

Manzano and Rigobon (2001) re-estimate SW's regressions using panel data. As they find similar results as in 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 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 last 30 years production in the resource sector has been declining and suggest focusing on the performance of non-resource GDP instead of 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 the results in three ways: 1) using different time periods; 2) the presence of omitted variable bias using fixed-effect estimation; 3) 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 the 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. Similar 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.

Besides 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 natural resource dependence 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 then 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. Doing so, they find that its effect on growth is statistically insignificant. Cerny and Filer (2007) achieves similar results. Namely, when the natural resource endowment measure is used instead of the natural dependence measure, its impact on growth becomes insignificant. This result leads them 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 more significant is the resource impact on growth. According to Sala-i-Martin et al. (2004), mining requires other conditioning variables to show its full impact.

Our 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. By matching similar countries we are able to control for unobservables. Increase in the controls of unobservables may lead to results similar to Sala-i-Martin et al. (2004), that is, that resource abundance has a positive effect on growth. Matching enables us not only to account for omitted variable bias, but also underlines the effect of resource abundance by putting more weight on similar countries.

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 $X_i = (x_i^1,...,x_i^N)$ for country i and $X_j = (x_j^1,...,x_j^N)$ for country j is computed as:

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

where N – is the number of variables (covariates) used to match the countries.

We define a threshold value for the distance measure $\overline{S}$. Two countries that have a distance below $\overline{S}$ are considered to be similar. There might be more than one country that is less than $\bar{S}$ distance from the country under consideration. The relative growth rates of country *i* with respect to country *j* are obtained as follows:

$$\tilde{Y}_{ij} = Y_i - Y_j \text{ for all } j\text{'s where } S_{ij} \in [0, \bar{S}] \quad (2)$$

It is worth noting that in (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:

$$Y_{it} = \delta_0 + X'_{it}\beta + \alpha R_{it} + \eta_i + \varepsilon_{it} \quad (3)$$

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 (3) may suffer from omitted variable bias. The omitted variable bias issue may be solved using fixed-effect estimation as is done 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 for the bias.

Of major interest in the resource impact literature is the effect of the variable R_{it} on growth. 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 natural resource exports share and natural resource production share. 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. And 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 that make the results of Manzano and Rigobon (2001) and Lederman and Maloney (2002) regarding the resource abundance variable statistically insignificant.

In this research, 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. The objective is to make sure that the best matches are obtained. After identifying the right matches, we proceed with estimating the effect of resource abundance on countries' relative growth performance.

Here, the variable of interest will be the relative growth rates of a country with respect to similar countries computed as in (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. In other words, if matching is performed based on observed country-specific characteristics, then 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 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, 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.

After computing relative growth rates on matched countries, we will 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:

$$\widetilde{Y}_{ijt} = \widetilde{\eta}_{ij} + \widetilde{\alpha}\widetilde{R}_{ijt} + \widetilde{\varepsilon}_{it} \qquad (4)$$

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

Different from (3), the above regression does not contain X_{it} and η_i. 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 makes it 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 them without including them into the regression.

4. Empirical results

4.1. Cross-country evidence

The initial step is to match all countries. In other words, we try to find matches for every country. We use exact matching using 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 that are robustly related to growth; the mining fraction of GDP is among those variables. We select those variables to match the countries. However, we exclude 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 see the impact of resource richness. Therefore, we have 17 variables to use for matching. Table 1 shows the list of variables used for matching.[3]

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 with each and every 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. This is because we have a limited number of countries. Therefore, we are only able to find the distance value closest to zero. We choose the threshold value for distance

[3] Please note that all the tables and graphs are at the end of the paper.

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 2).

After identifying matches we compute the relative growth rates of every country with respect to each of the matched countries as in (2). By doing so, we obtain our dependent variable $\widetilde{Y}_{it}$ as in equation (4). We estimate the impact of the relative resource abundance variable to the relative growth rate variable.

It is crucial to note 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. If agricultural, fishing and forestry products are non-exhaustible and renewable; however, mining and quarrying products are non-renewable and exhaustible in the predictable future. Additionally, considering the different nature of primary products, in this paper we separate exhaustible and non-renewable resources from non-exhaustible and renewable resources. In other words, different from Sachs and Warner (1995) and others, we would like to focus on exhaustible resources as well. Here, exhaustible resources include only mineral resources that are 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 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 would like to weight every observation (pair) by its assigned distance measure. In other words, we will also apply weighted least squares (WLS) estimation using distance as the weighting criterion.[4] The WLS estimation yields the results seen in Table 4.

Table 4 shows that the results have not changed much when using WLS estimation. This may indicate successful choice of threshold value $\overline{S}$, so that countries lying within that distance from a focus country might be comparable to it.

In Table 3 (and similarly in Table 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 what has been claimed by SW. Furthermore, (5)-(2) and (5)-(5) show there to be 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 down 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 the results obtained by SW, namely that resource abundance has a negative impact on

[4] As different countries have a different number of matched pairs, we also looked at the weighting observations by number of available pairs for each country. The results do not differ significantly from the ones in Table 3 and 4, and hence are not reported here.

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). In general, 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. In other words, the resource measures based on primary products, which include also 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.

If we compare 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) then we see that primary exports have a positive effect on growth whereas mineral exports have a negative impact.

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

In Table 3 (and Table 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 Sachs and Warner (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 gets stronger. Therefore, it is important to justify our results in comparison to SM's results. But first, we need to understand those differences.

To do so, first of all, using SM's dataset we estimate growth regression (3) by including all 18 robust explanatory variables shown in SM. The regression estimation in Table 5 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 (3) we compute resource-based growth as follows:

$$RBG = Y_{it} - NBG = Y_{it} - \hat{\delta}_0 - X'_{it}\hat{\beta} = \hat{\alpha}R_{it} + \hat{\eta}_i + \hat{\varepsilon}_{it} \qquad (5)$$

SM's results show that resource abundance is positively related to growth; this implies that as resources increase then resource-based growth also increases, as shown in Figure 1. That is, the coefficient $\hat{\alpha}$ has a positive sign.

We also calculate the error term of the regression. To see whether there is an omitted variable issue with this regression, we check the sample correlations between the error term and other explanatory variables, shown in Table 6. It is important to note that the error term in regression (3) contains country-specific characteristics η_i as well.

Table 6 indicates that there is a strong correlation between the error term and explanatory variables, which leads to a bias in the regression coefficients. This creates a suspicion that there is an omitted variable bias. 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 not only control for observables but also control for unobservables.

We apply the matching methodology to the obtained regression results. In other words, we use the already matched countries in Table 3, and calculate relative resource-based growth rates and relative resource abundance. Interestingly, the sign of $\hat{\alpha}$ is negative, opposite to the original regression (3) results (Figure 2).

Figure 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 would 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. In other words, 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.

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 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 the difference between next year's export share and the previous year's export share is bigger 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 7 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 bigger than 20%; for Cameroon this is 1978. Figure 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 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 3 through 22 (for each "treatment" country), and Figure 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.

5. Concluding remarks

In this paper, we analyse the impact of resource richness on a country's GDP per capita performance with respect to another similar country. 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 abundnace 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. In other words, depending on whether a primary products-based resource abundance measure or mineral products-based resource abundance measure is used, the nature of the results are different in these cases. 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 their estimation is subject to omitted variable bias. In this respect, the matching methodology we employ aims to control for country-specific unobservables which puts the estimation in an advantageous position. 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. That is, by changing time period 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: Angola, Cameroon, the Republic of Congo, Ecuador, Egypt, Mauritania, Mexico, Morocco, Niger, Nigeria, Norway, Papua New Guinea, Senegal and Togo. By as a significant increase we mean that in a particular year the difference between next year's export share and the previous year's export share is bigger than 20% and that this increase persists over 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. In other words, there is a boom for a short time followed by long period of bust. The length of the boom and bust periods varies 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.

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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).

8. Tables

Table 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 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 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 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 2 continued

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

Table 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 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 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 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 3: The impact coefficients of relative resource abundance on relative growth as in equation (4), OLS estimation, with the bootstrap estimates of the standard errors (replications=1000)

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

Table 4: The impact coefficients of relative resource abundance on relative growth as in equation (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 5: 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 6: The correlations between error term and explanatory variables as per regression (3)

	ERROR TERM	MINING
GR6096	0.964	-0.151
MINING	-0.193	1.000
EAST	0.563	-0.035
P60	0.619	-0.118
IPRICE1	-0.454	0.012
GDPCH60L	0.349	-0.064
TROPICAR	-0.496	0.074
DENS65C	0.470	-0.132
MALFAL66	-0.619	0.182
LIFE060	0.623	-0.196
CONFUC	0.510	-0.083
SAFRICA	-0.637	0.069
LAAM	-0.108	-0.084
SPAIN	-0.109	-0.065
YRSOPEN	0.677	-0.189
MUSLIM00	-0.002	0.300
BUDDHA	0.490	-0.116
AVELF	-0.479	0.244
GOVSH61	-0.356	0.068

Table 7: 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 3 and Figure 4
Congo	Namibia and Benin	1972	Figure 5 and Figure 6
Ecuador	Peru, Bolivia and El Salvador	1972	Figure 7 and Figure 8
Egypt	United Arab Emirates	1978	Figure 9
Mauritania	no matches identified within defined distance	1962	not available
Mexico	Colombia and Nicaragua	1980	Figure 10 and Figure 11
Morocco	Bahrain and Tunisia	1974	Figure 12 and Figure 13
Niger	Mali, Namibia, Sudan, Senegal, Sierra Leone and Tanzania	1973	Figure 14 and Figure 15
Nigeria	Cote d'Ivoire, Guinea-Bissau, Ghana, Mali, Ethiopia, Burkina Faso, Kenya, Guinea and Uganda	1968	Figure 16 and Figure 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 18 and Figure 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 20
Togo	Tanzania, Zambia, Malawi and Guinea-Bissau	1962	Figure 21 and Figure 22

9. Figures

Figure 1: Resource-based growth and resource abundance

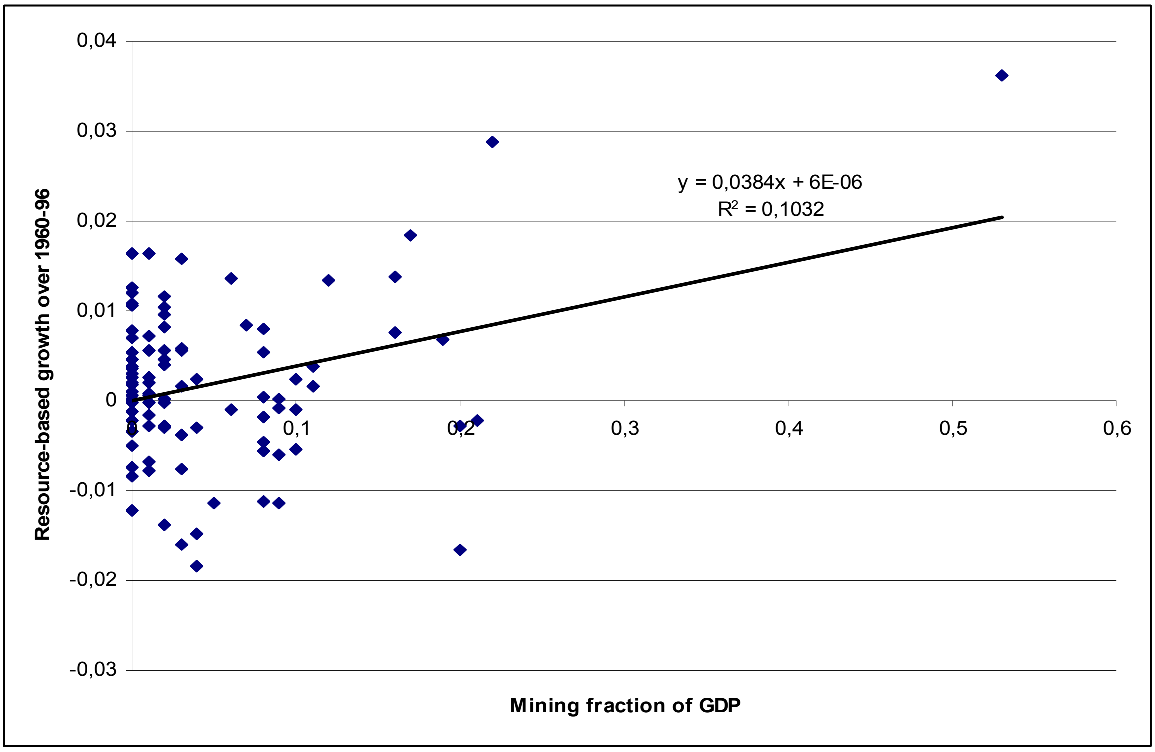


Figure 2: The relative resource richness and relative resource-based growth

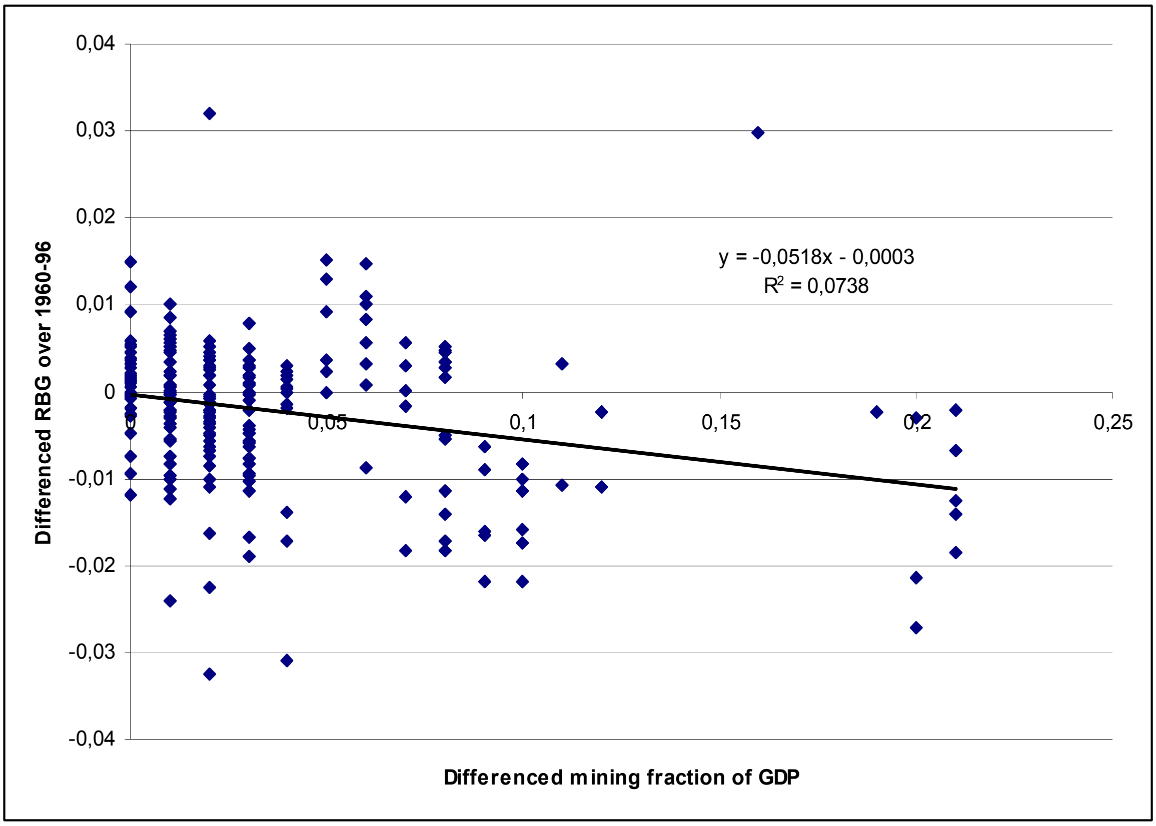


Figure 3: Cameroon with respect to Uganda, Namibia, Nigeria, Ghana and Cote d'Ivoire Relative real GDP per capita ($ in 2000 Constant Prices: Lasp.) 1978=100

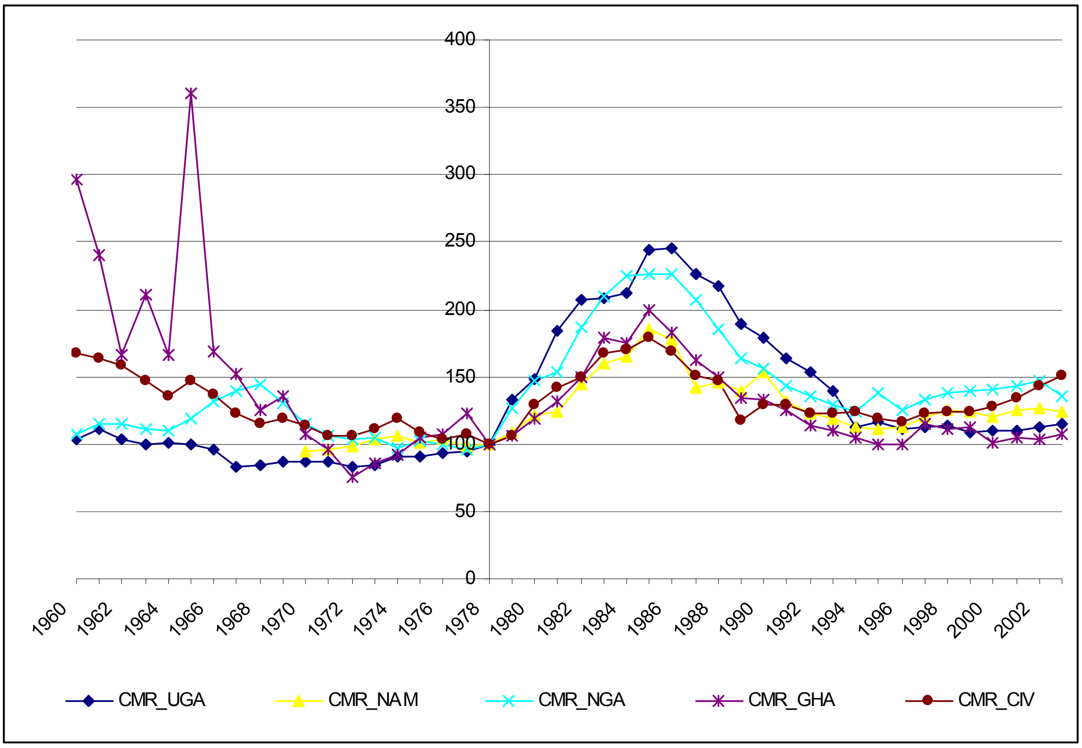


Figure 4: Cameroon with respect to the average of Uganda, Namibia, Nigeria, Ghana and Cote d'Ivoire Relative real GDP per capita ($ in 2000 Constant Prices: Lasp.) 1978=100

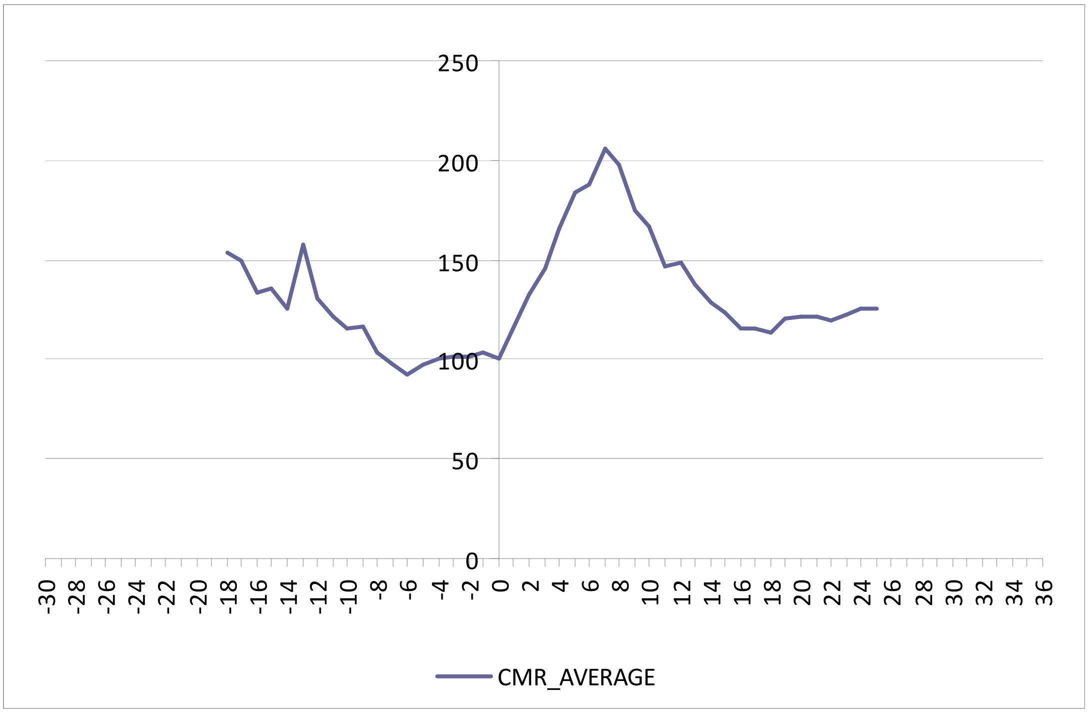


Figure 5: The Republic of Congo with respect to Namibia and Benin, 1962=100

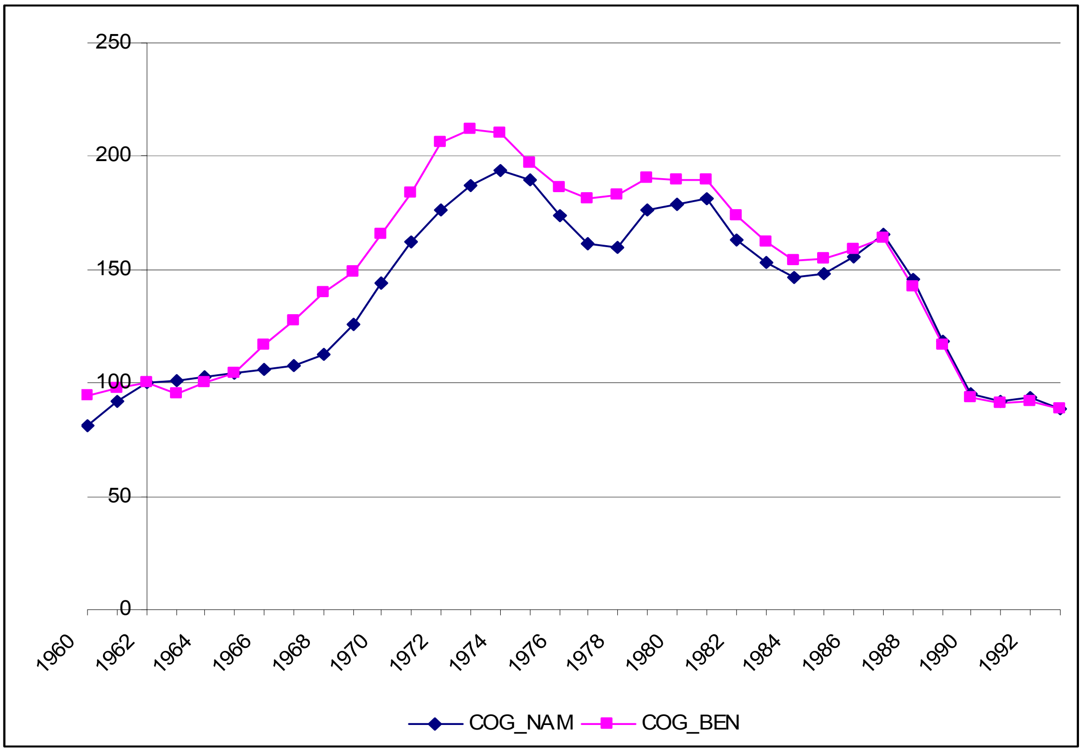


Figure 6: The Republic of Congo with respect to the average of Namibia and Benin, 1962=100

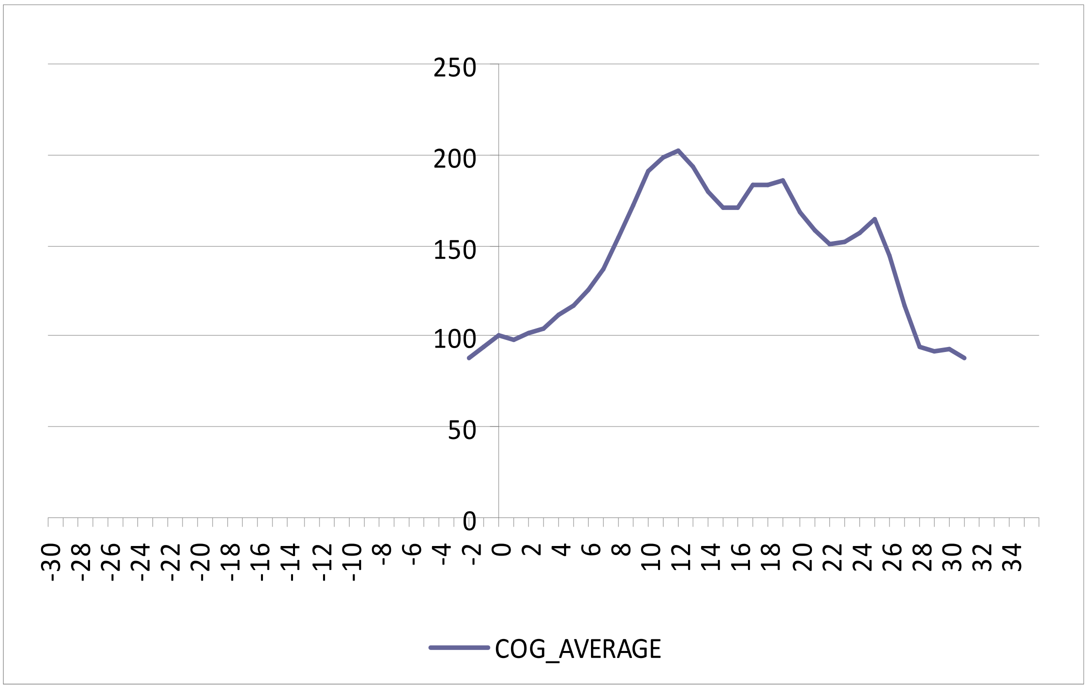


Figure 7: Ecuador with respect to Peru, Bolivia and El Salvador, 1972=100

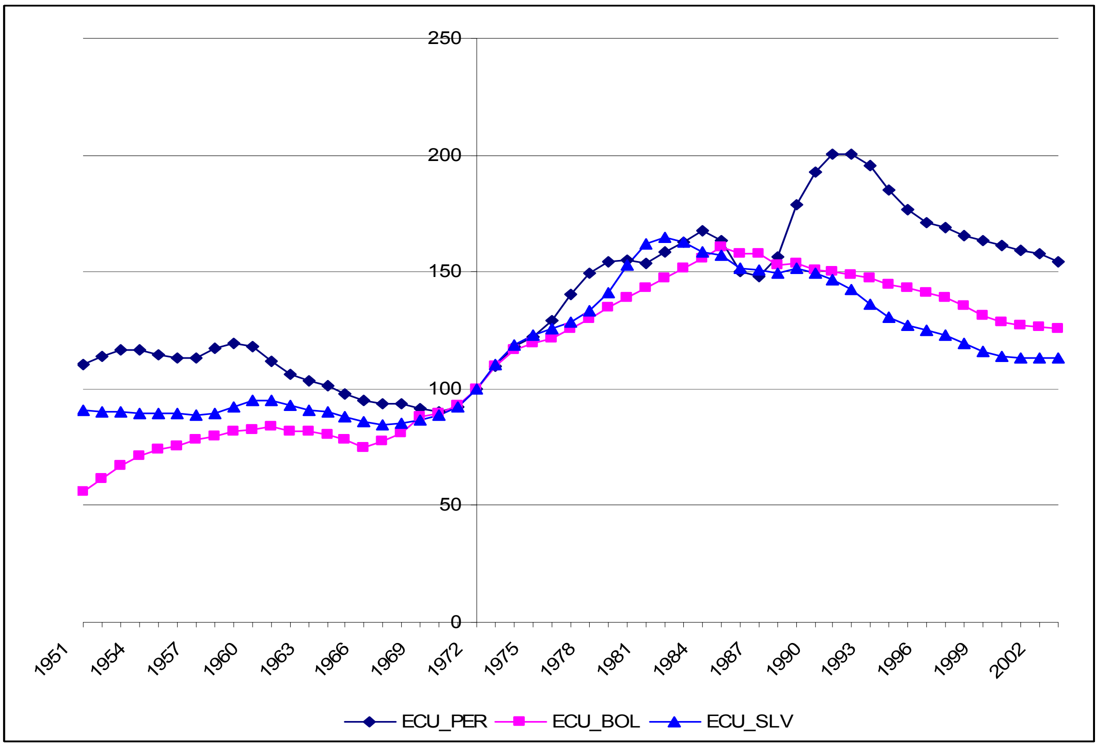


Figure 8: Ecuador with respect to the average of Peru, Bolivia and El Salvador, 1972=100

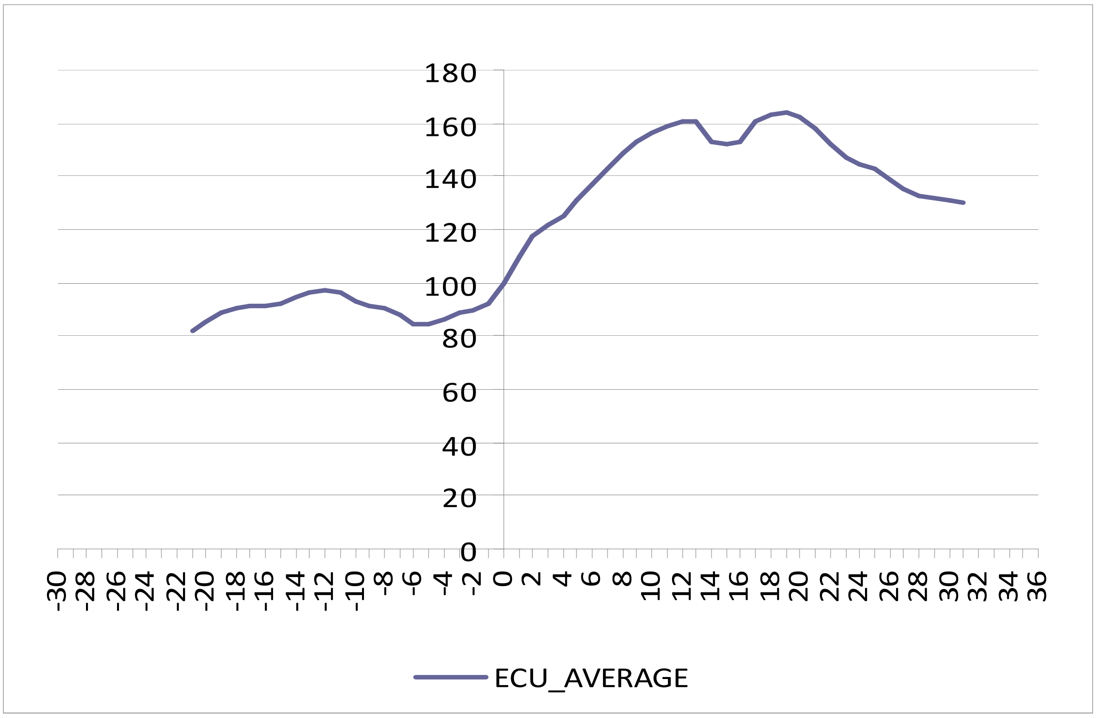


Figure 9: Egypt with respect to United Arab Emirates, 1978=100

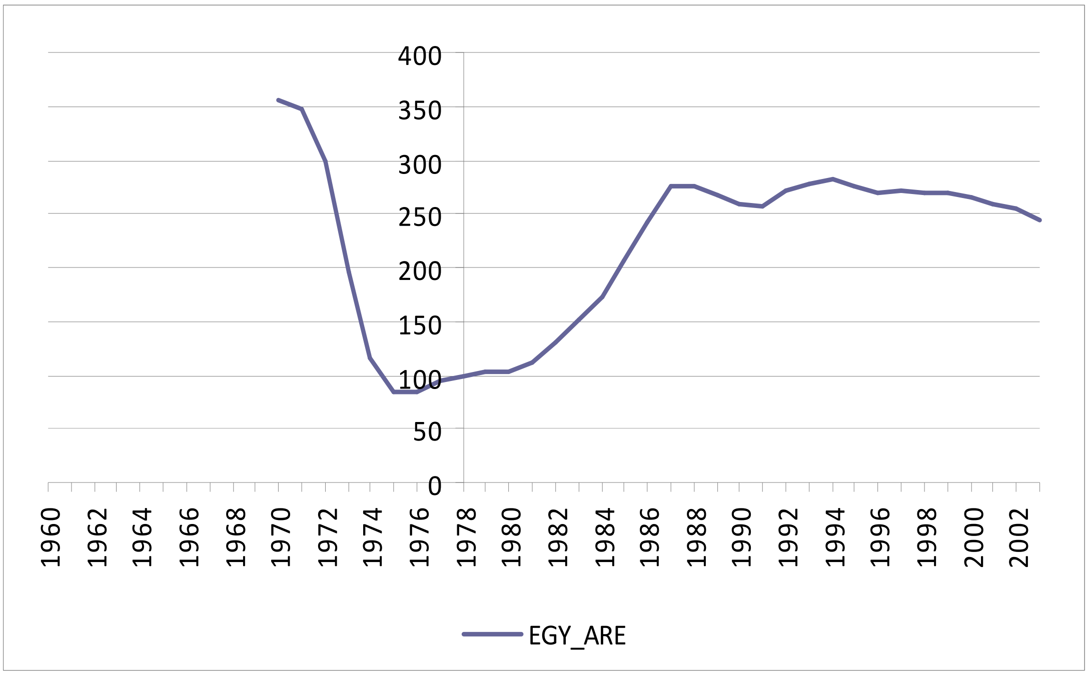


Figure 10: Mexico with respect to Colombia and Nicaragua, 1980=100

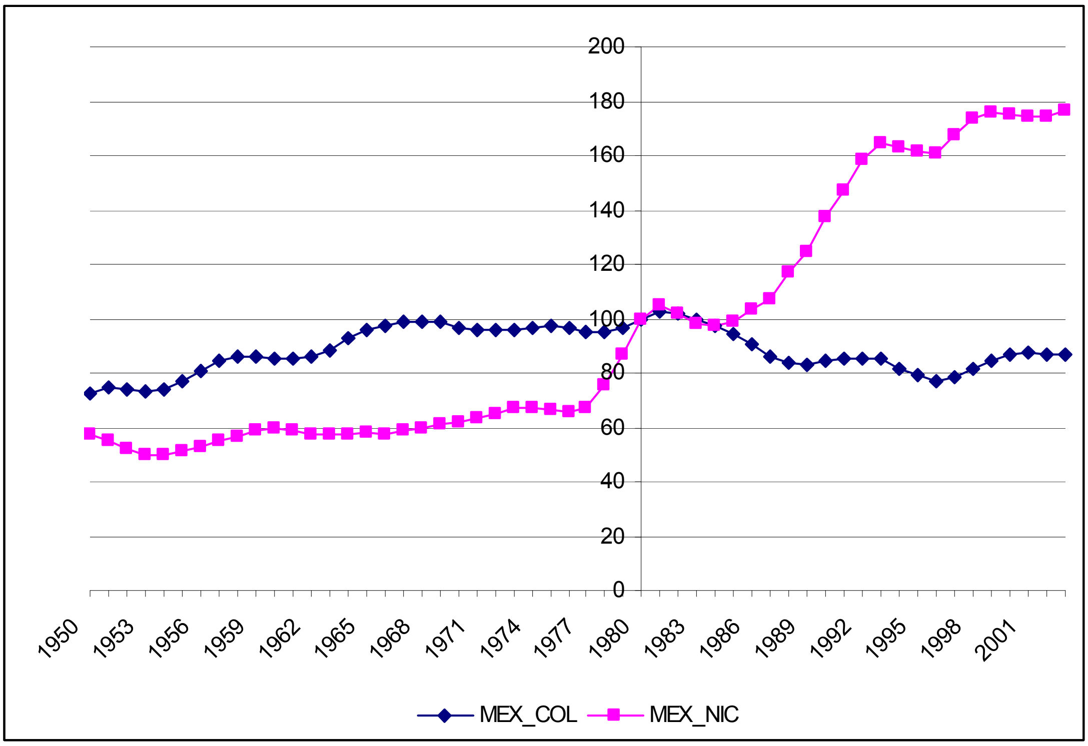


Figure 11: Mexico with respect to the average of Colombia and Nicaragua, 1980=100

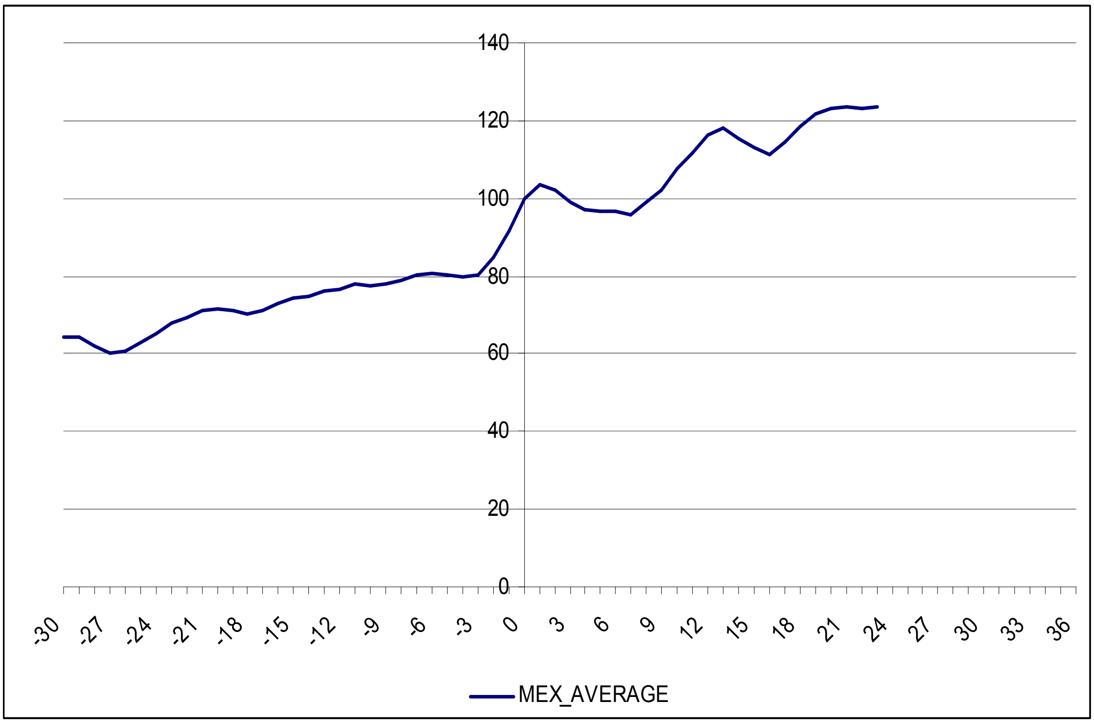


Figure 12: Morocco with respect to Bahrain and Tunisia, 1974=100

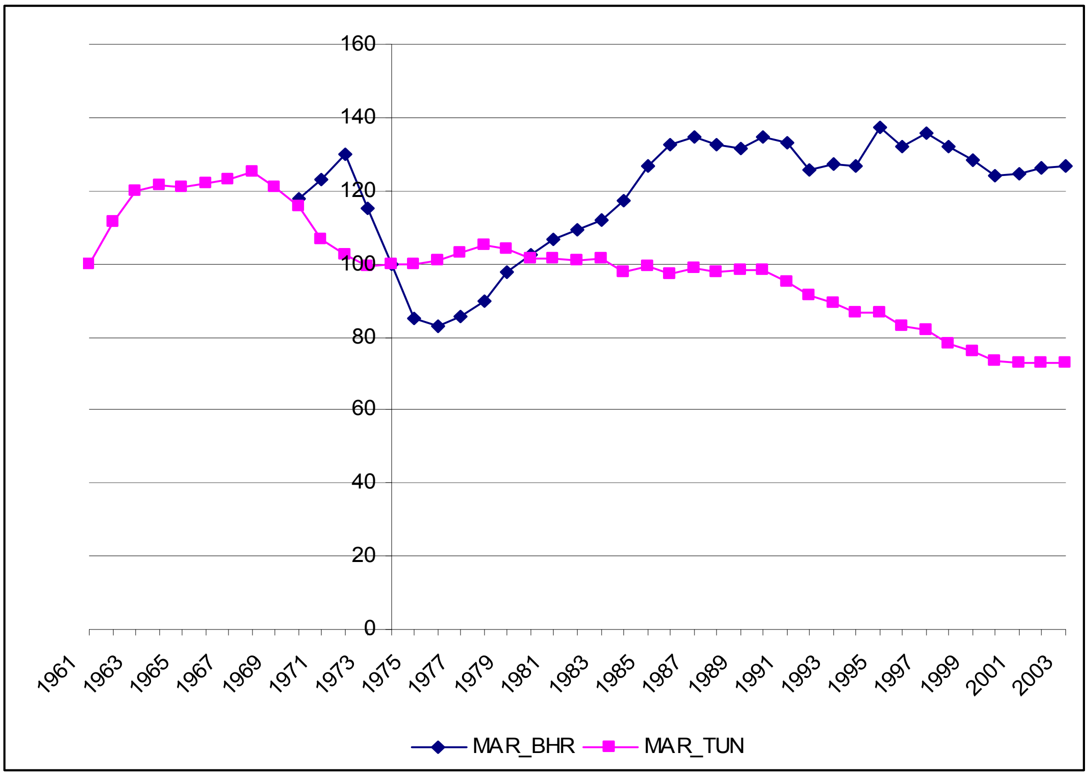


Figure 13: Morocco with respect to the average of Bahrain and Tunisia, 1974=100

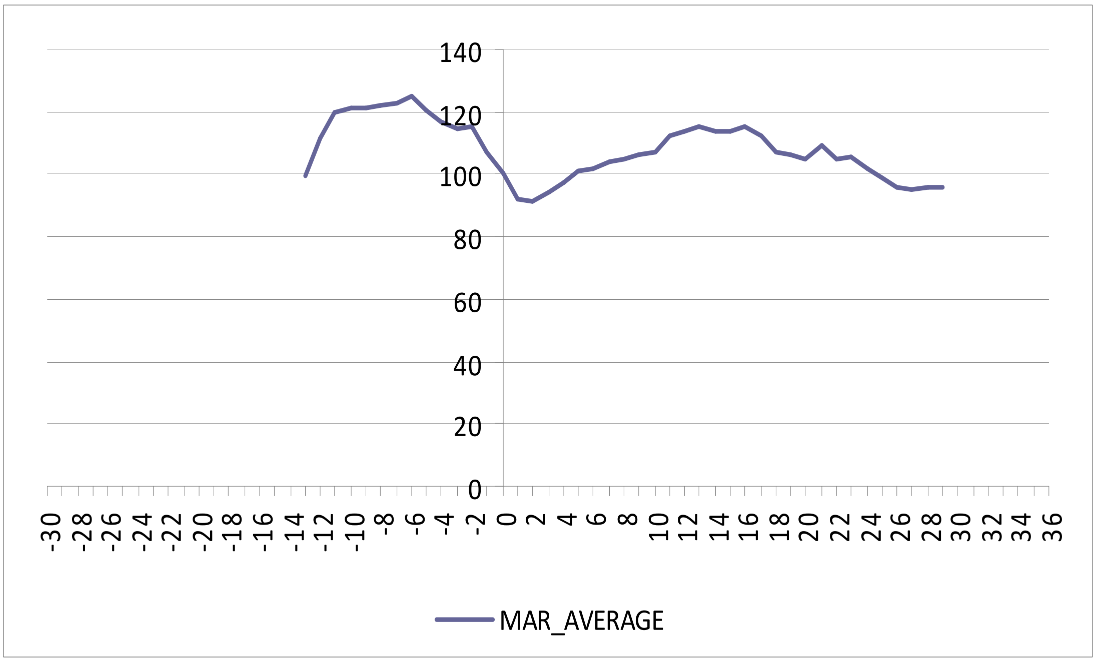


Figure 14: Niger with respect to Mali, Namibia, Sudan, Senegal, Sierra Leone and Tanzania, 1973=100

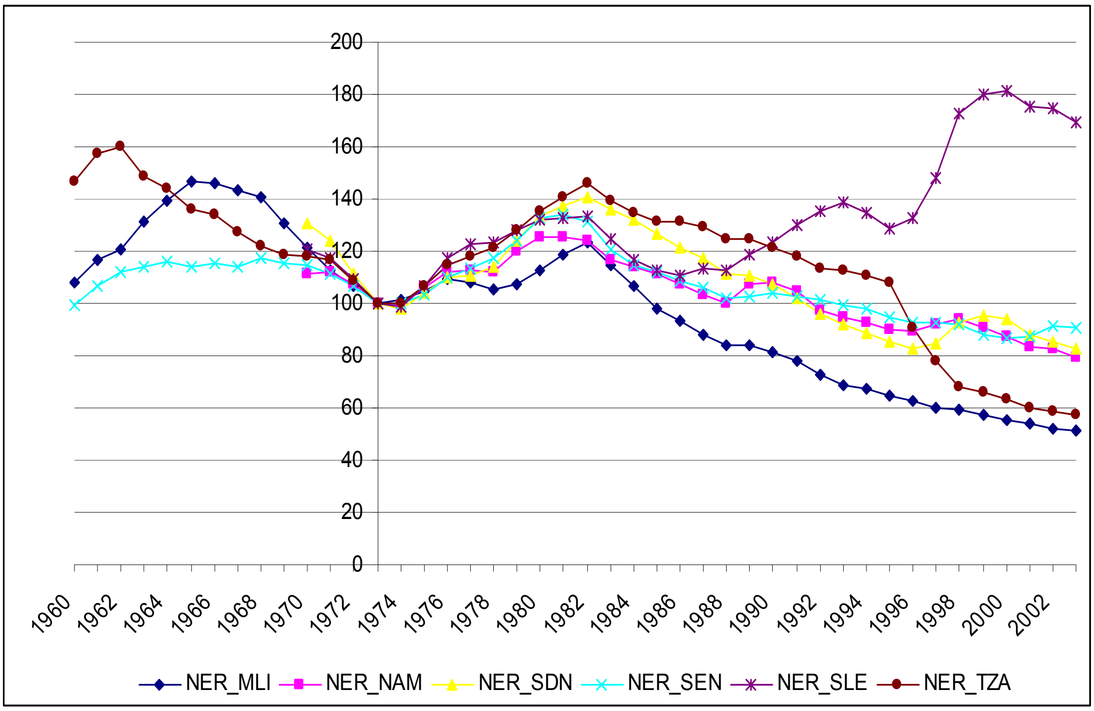


Figure 15: Niger with respect to the average of Mali, Namibia, Sudan, Senegal, Sierra Leone and Tanzania, 1973=100

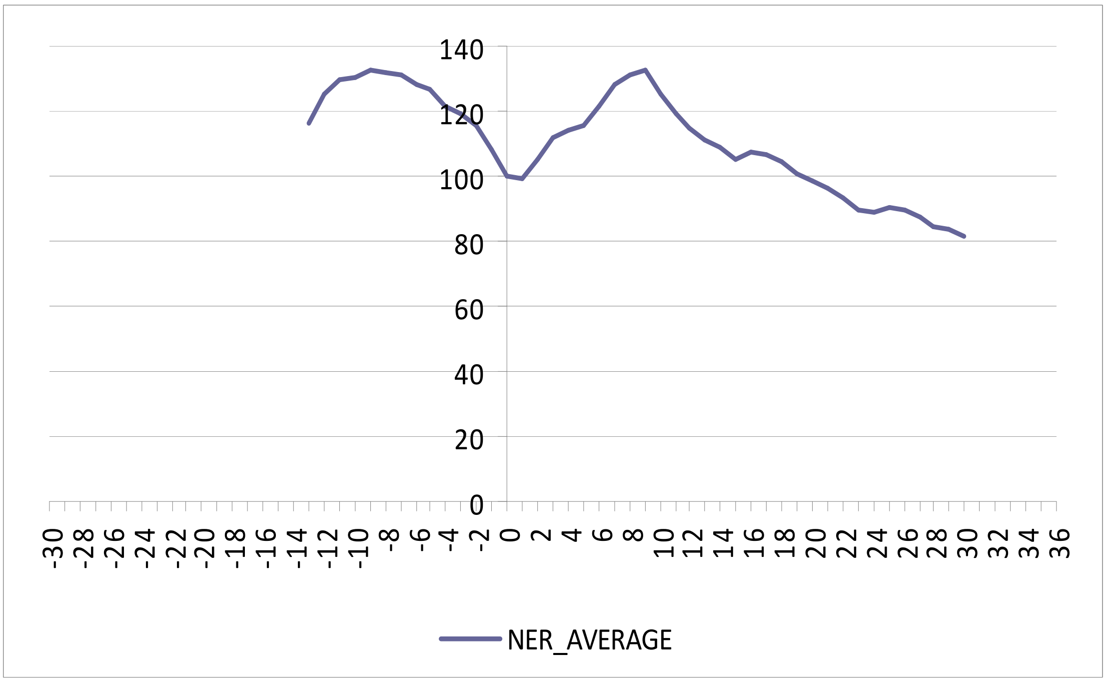


Figure 16: Nigeria with respect to Cote d'Ivoire, Guinea-Bissau, Ghana, Mali, Ethiopia, Burkina Faso, Kenya, Guinea and Uganda, 1968=100

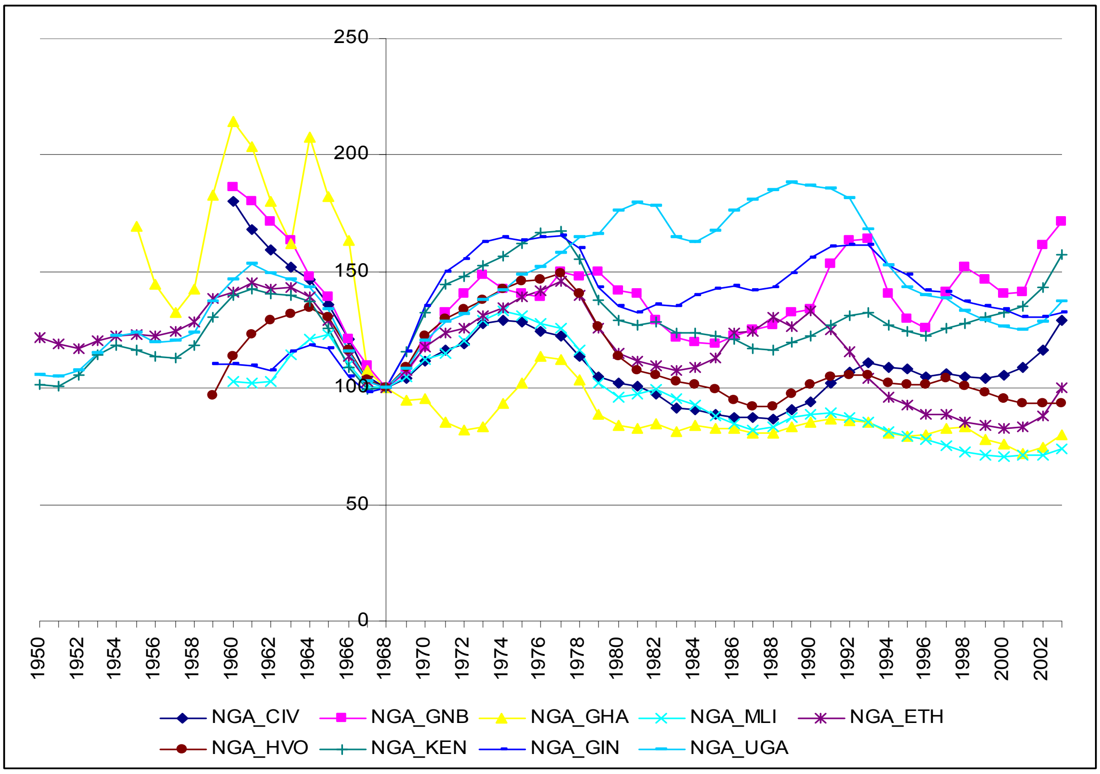


Figure 17: Nigeria with respect to the average of Cote d'Ivoire, Guinea-Bissau, Ghana, Mali, Ethiopia, Burkina, Faso, Kenya, Guinea and Uganda, 1968=100

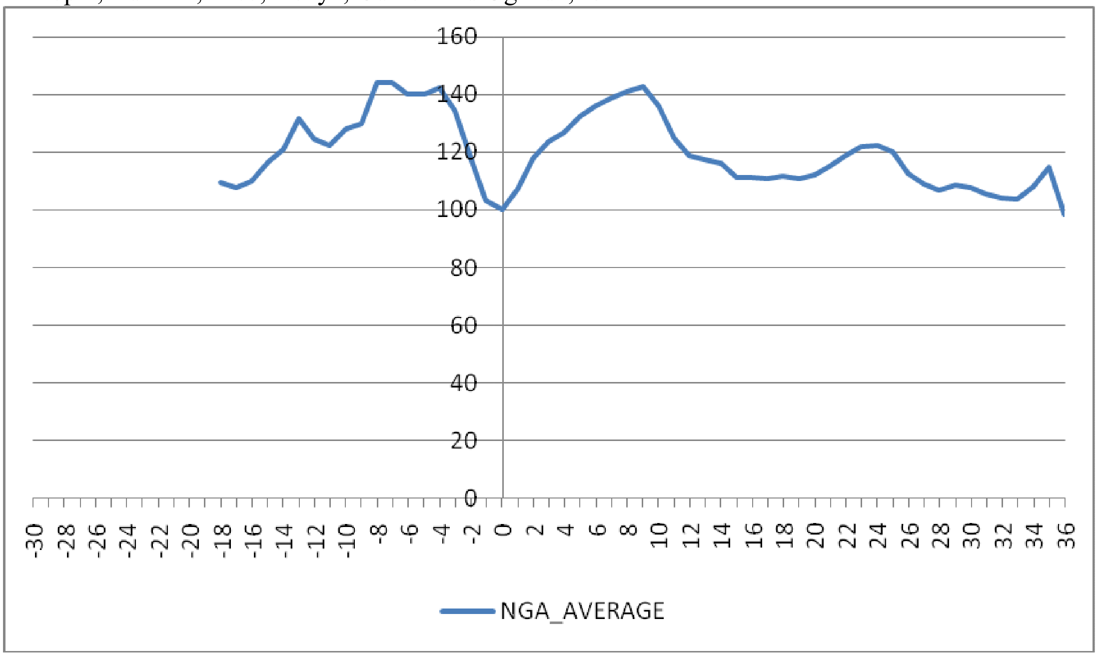


Figure 18: Norway with respect to Iceland, Austria, Denmark, Finland, France, Italy, Sweden, Ireland, Netherlands, Luxembourg, UK, USA, Spain, Greece, Belgium, Switzerland and Portugal, 1978=100

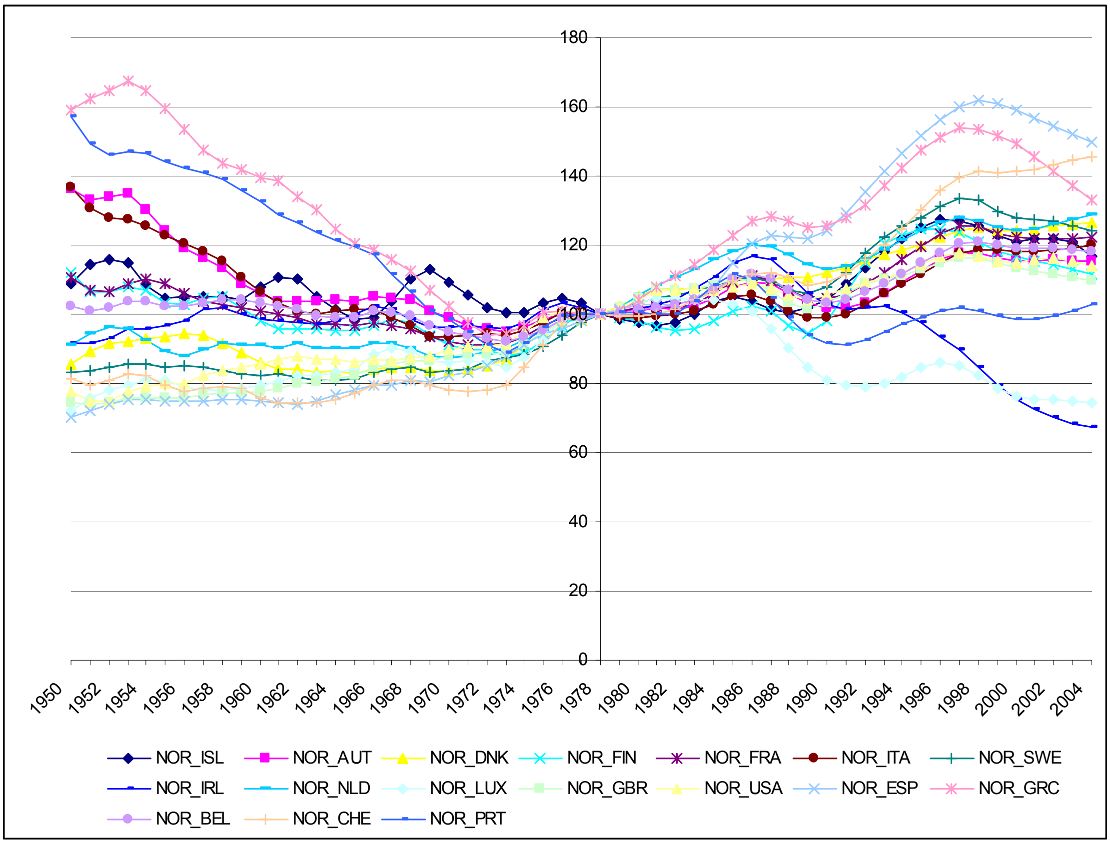


Figure 18: Norway with respect to the average Iceland, Austria, Denmark, Finland, France, Italy, Sweden, Ireland, Netherlands, Luxembourg, UK, USA, Spain, Greece, Belgium, Switzerland and Portugal, 1978=100

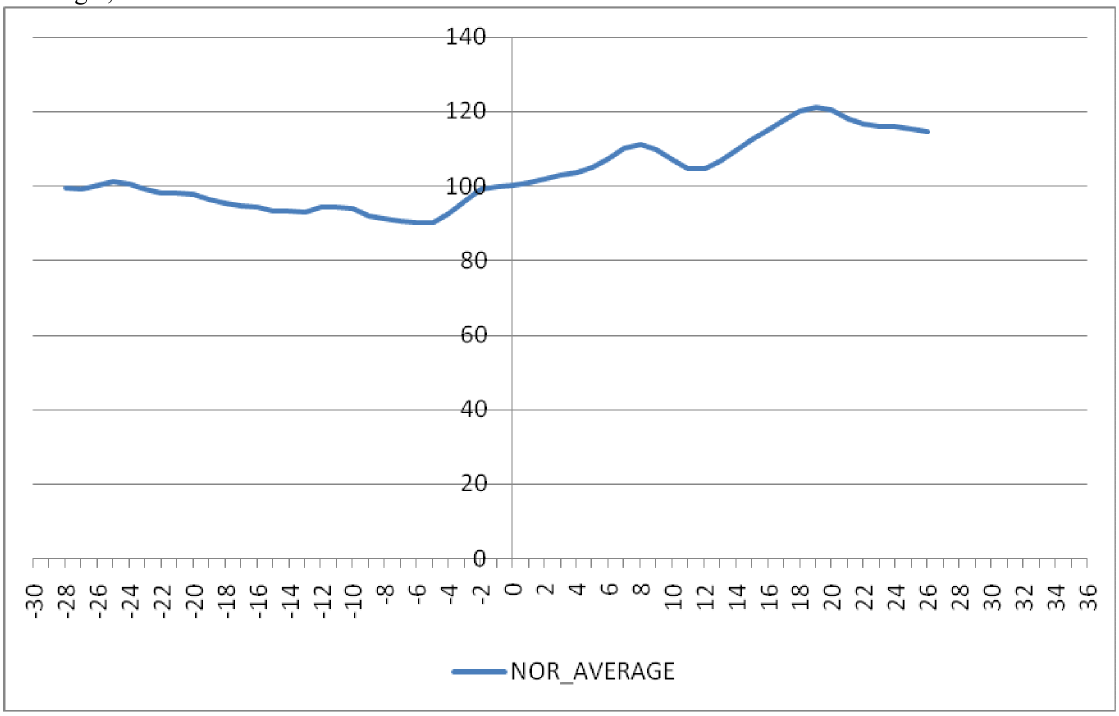


Figure 20: Senegal with respect to Sudan, 1980=100

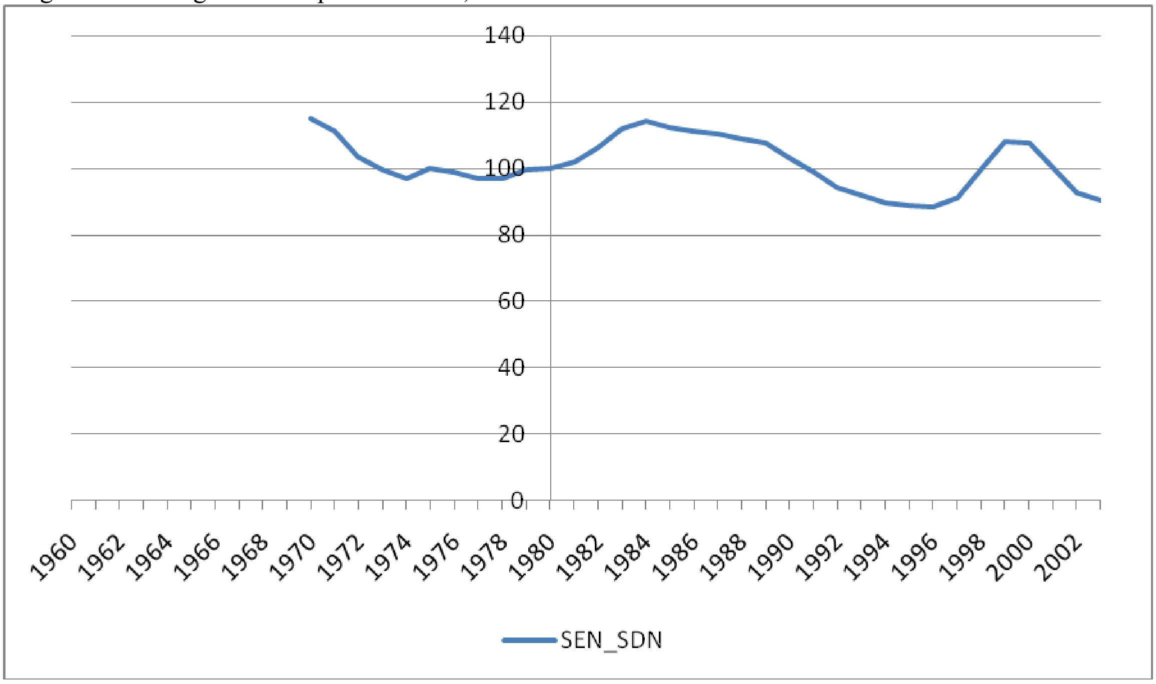


Figure 21: Togo with respect to Tanzania, Zambia, Malawi and Guinea-Bissau, 1982=100

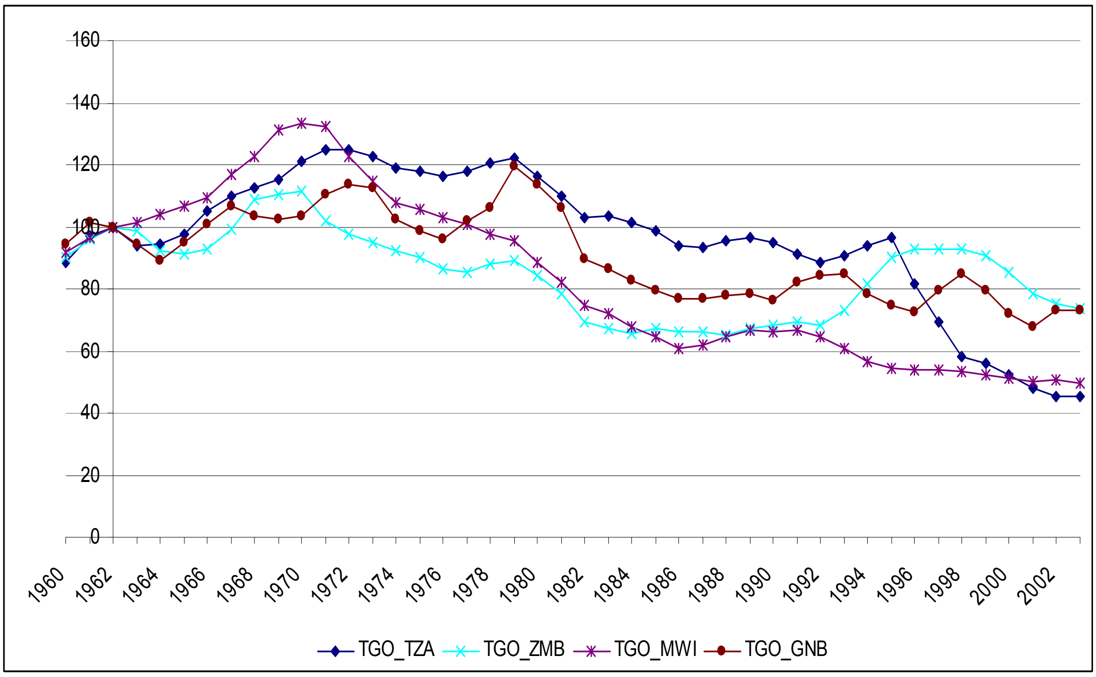


Figure 22: Togo with respect to the average of Tanzania, Zambia, Malawi and Guinea-Bissau, 1982=100

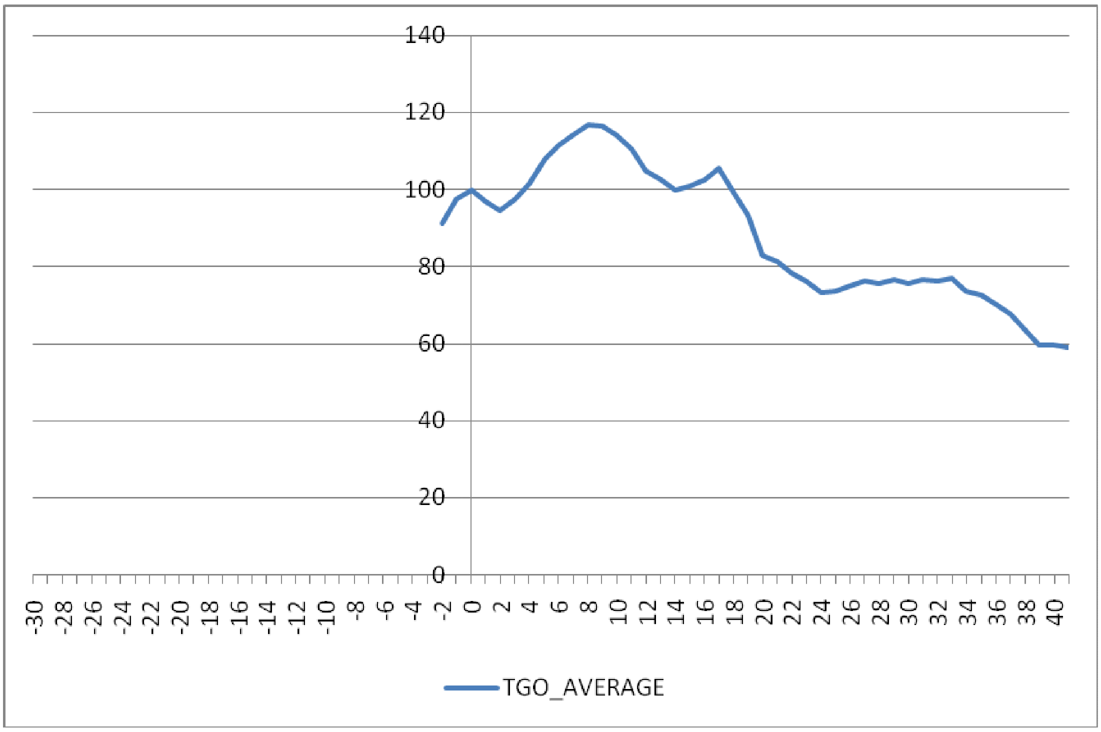
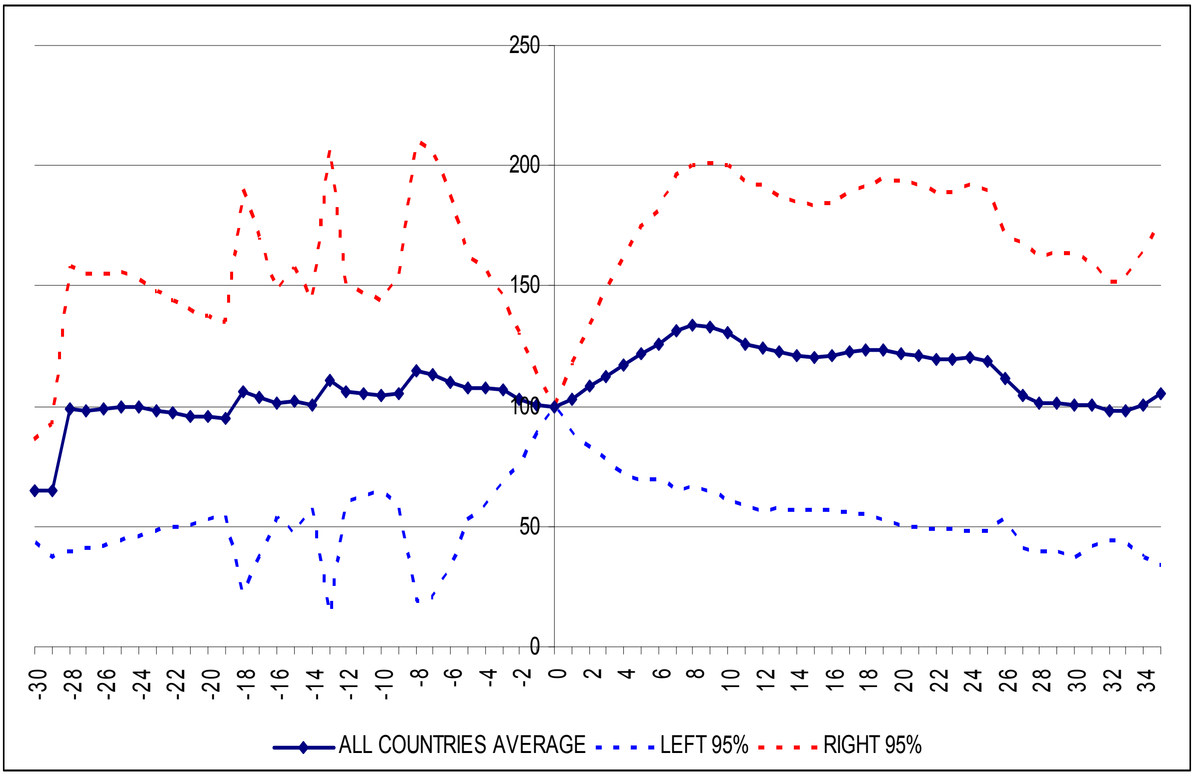


Figure 23: All countries average*, break date=100



*excluding last 6 years for Togo

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