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Sources of Growth in the Democratic Republic of the Congo: A Cointegration Approach

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and
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Sources of Growth in the Democratic Republic of the Congo: A Cointegration Approach

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Abstract

The paper investigates the sources of growth in the Democratic Republic of the Congo since 1960 and evaluates the relative importance of total factor productivity growth and factor accumulation, using a cointegration method and a growth accounting framework. The main findings confirm that poor economic policies and bad governance (through their effects on total factor productivity and capital accumulation) contributed to the country's economic decline during the 40-year period, 1960–2000. Looking forward, the paper finds that the right policies are being put in place to pave the way for a restoration of economic growth.

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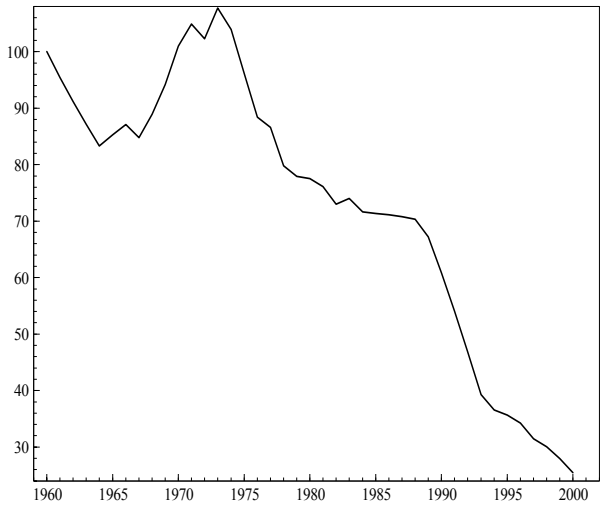
I. INTRODUCTION

The Democratic Republic of the Congo (DRC),[2] with a population of over 55 million people, is endowed with vast natural resources including perhaps the most extensive network of navigable waterways in Africa. It also has a vast hydroelectric potential that remains largely untapped. Despite its economic potential, economic activity showed a drastic decline during the period 1960–2000, as can be seen in the figure below.0 Per capita GDP fell steadily from US$380 in 1960 to US$240 in 1990 and further to US$85 (or 23 cents a day) in 2000, placing the country among the poorest in the world (Figure 1). The dramatic decline in output and income has been the result of inappropriate economic and financial policies, pervasive corruption, and, especially in the past decade, political turmoil, civil strife, and full-fledged war since 1998.

Figure 1. Democratic Republic of the Congo: Real GDP per Capita (Index, 1960=100)



Sources: Congolese authorities; and IMF staff estimates.

However, since early 2001, the authorities have started addressing the alarming economic and social situation by stabilizing the macroeconomic situation, liberalizing the Congolese economy, and opening it up to the rest of the world. With its critical mass of macroeconomic policies and far-reaching structural reforms, the government's enhanced interim program (EIP), covering the period June 2001–March 2002, was a crucial first step toward stabilizing the country's economic situation and laying the foundations for reconstruction and the restoration of growth. The EIP has produced significant results, in particular bringing hyperinflation to a halt, strengthening public finances, and laying a foundation for the resumption of growth. In 2002, for the first time in 13 years, real GDP growth was estimated

[2] The DRC gained its independence in June 1960.

to be positive, at about 3 percent. Building on these achievements, a program (covering the period April 2002–July 2005) supported by an arrangement under the IMF's Poverty Reduction and Growth Facility (PRGF) is being implemented with the aim of reconstructing the country and reviving economic growth.

This study has three objectives. First, it investigates econometrically the sources of growth in the DRC and evaluates the relative importance of movements in productivity and factor accumulation. Unlike most studies on sources of growth, the analysis is extended to the key sectors of the economy: agriculture, mining, and transport. A cointegration technique is used to estimate the production function, thereby preserving the long-run information in the data. Second, the paper assesses the DRC's medium-term growth prospects and compares them with both the post-conflict growth experience to date and the growth objectives of the government's economic program. Third, based on the econometric findings, the paper suggests a simple methodology for projecting the real GDP growth rate.

The paper is organized as follows. Section II provides a brief background on the Congolese economy, focusing on economic performance during 1960–2000. Section III presents the theoretical framework and econometric methodology for analyzing the sources of growth. Section IV conducts the growth accounting exercise and analyzes the sources of growth. Section V reviews the recent policy reforms and assesses medium-term growth prospects. Section VI highlights the main conclusions and their policy implications.

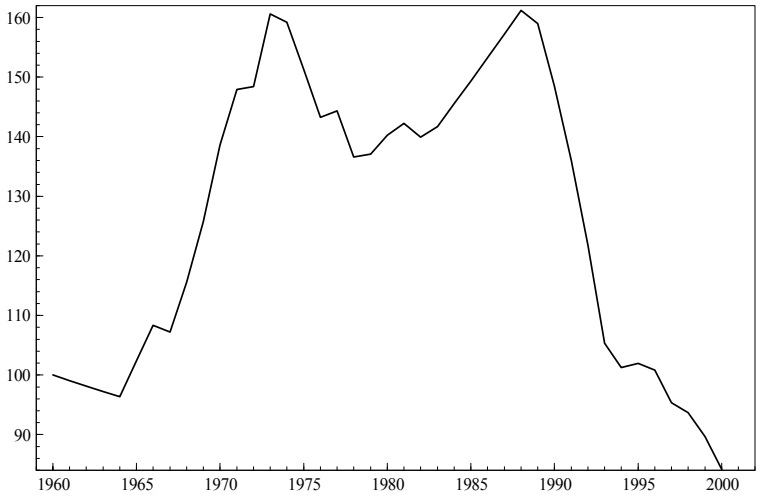
II. Economic Performance from 1960 to 2000

Focusing on the key constraints and policies that have hampered economic growth, this section analyzes both overall and sectoral growth performance. The factors constraining the DRC's economic performance have included ineffective governance and administrative bottlenecks, ill-conceived economic policies, transportation difficulties, lack of basic infrastructure, and insufficient confidence among potential local and foreign investors.

A. Overall Output Performance

As mentioned previously, the DRC's overall economic performance has been extremely disappointing, notwithstanding the country's rich endowments of natural and human resources. Four decades have been lost to total mismanagement of the economy and lack of overall governance; real GDP in 2000 is below its 1960 level (Figure 2). Following Maton, Schoors, and Van Bauwel (1998), the evolution in real GDP since 1960 can be usefully divided into five subperiods: (a) 1960–65: political chaos and economic disruption; (b) 1966–74: stability and growth; (c) 1975–82: economic recession and debt crisis; (d) 1983–89: adjustment under the IMF and stop-and-go policies; and (e) 1990–2000: hyperinflation and collapse of the economic and political system.

Figure 2. Democratic Republic of the Congo: Real GDP (Index, 1960 = 100)



Sources: Congolese authorities; and IMF staff estimates.

1960–65: Political chaos and economic disruption

This period witnessed a decline in output because of disruption in the transport network and the departure of many foreign entrepreneurs following political turmoil, civil strife, and the failed secession of the Katanga Province. Real GDP declined by about 4 percent between 1960 and 1965.

1966–74: Stability and growth

This period was characterized by increased involvement of the state in the productive sectors of the economy. Thanks to *La Politique des Grands Travaux,*[3] public investment quadrupled. In 1971, the first Mobutu plan (Plan Décennal 1971–80) was launched, which aimed to raise real GDP growth to about 7 percent per year. Against this backdrop, in 1973–74 the government took steps toward the nationalization of all small, medium-sized, and large foreign enterprises.

Increasing state control of the economy was accompanied by an impressive economic expansion, with real GDP growing at an average annual rate of 5.1 percent during 1966–74. However, following the adverse terms of trade shocks caused by both a reversal in copper prices and the oil crisis of 1973, the centralized economy, unable to adjust, soon revealed its severe limitations.

[3] *La Politique des Grands Travaux* was an ambitious plan for economic development aimed at implementing prestigious and large-scale projects.

1975–82: Economic recession and debt crisis

The ill-advised economic policies and public investments of the early 1970s precipitated a debt crisis with a damaging impact on economic activity. In 1975, the country stopped servicing its debt and requested an IMF-supported program for the first time to help extricate the DRC from its economic crisis. Because of the overall downturn, the public investment program was grounded, capital invested in "white elephants" was lost, and the maintenance of infrastructure and productive capital was neglected or postponed indefinitely. As a result, economic activity experienced a severe decline, compounded by the invasions of the Shaba Province (the heart of mining activities) in 1977 and 1978. Altogether, real GDP fell by 12 percent.

1983–89: Adjustment supported by the IMF and stop-and-go policies

To improve the economic and financial situation, and eliminate the significant distortions that had grown in the preceding period, the government started to implement in September 1983 a strong stabilization and liberalization program. This strategy had a positive impact as real GDP, which had declined by 2.2 percent in 1982, recovered with an average annual growth rate of 2.6 percent during the period, 1984–86.

In 1987, with the support of the IMF and the World Bank, the government launched a structural adjustment program aimed at establishing the basis for long-term economic growth and a sustainable external financial position. The program also benefited from improved terms of trade, mostly reflecting a strong upturn in copper prices beginning in early 1987. However, with the more favorable external environment, the government all but ceased its adjustment efforts. As a result, the country's financial performance deteriorated markedly. Annual real GDP growth decelerated to 0.5 percent on average during the period 1987–89.

1990–2000: Hyperinflation and collapse of the economic and political system

In the midst of failed attempts at political liberalization, control over economic policies was lost, and the country fell into the grip of an unprecedented circle of hyperinflation, currency depreciation, increasing dollarization and financial disintermediation, declining savings, deteriorating economic infrastructure, and broad-based output decline. The alarming economic and social situation was compounded by the full-fledged war that broke out on August 2, 1998.

In this context, a large part of the country's capital stock was destroyed, and investment was discouraged. As a result, real GDP contracted cumulatively by some 43 percent during the decade, and per capita real GDP plummeted from US$224 in 1990 to US$85 (23 cents a day) in 2000. Over the same period, consumer prices rose at an annual average rate of 684 percent. Government revenue fell by 80 percent, and external debt rose to about 300 percent of GDP (or almost US$13 billion).

B. Sectoral Output Performance

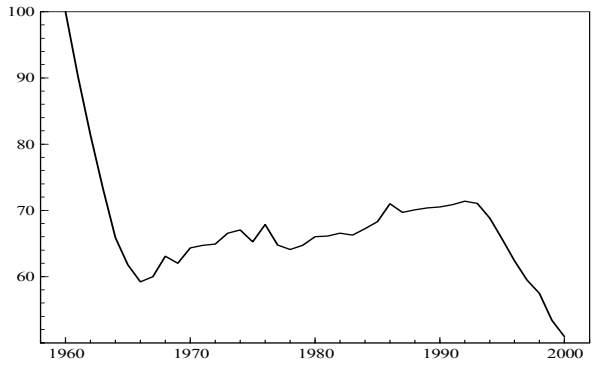
Based on their contributions to GDP, agriculture, mining, and transport are the most important sectors.

Agriculture

Combined with forestry, animal husbandry, and fishing, agriculture provides direct employment to more than 75 percent of the labor force and accounts on average for about 45 percent of real GDP. Agriculture has great potential as a source of economic growth, export diversification, and gainful employment. Nevertheless, agricultural output has not recorded substantial growth (Figure 3), and its contribution to exports declined continuously from about 40 percent of exports in 1960 to less than 10 percent in 2000, with some traditional export products virtually not being grown any more.[4] With regard to food crops, Maton, Schoors, and Van Bauwel, (1998) have shown that food surplus for each person increased between 1965 and 1974; thereafter, a steep downward trend began, partly owing to the *Zaireanisation*[5] process, which has undermined productivity growth.

Overall, agricultural development has been constrained by several factors. These include the deterioration of the network of rural feeder roads; the dislocation caused by the *Zaireanisation* measures of 1973–74; inadequate credit for small-scale producers; lack of foreign exchange for essential imports; insufficient storage and other marketing facilities; and the uncertainties created by the government's pricing policies.

Figure 3. Democratic Republic of the Congo:
Agricultural Real Value Added per Worker (Index, 1960 = 100)



Sources: Congolese authorities; and IMF staff estimates.

[4] Exports mainly consist of oil products, cotton, cocoa, coffee, tea, and forestry products.

[5] The *Zaireanisation* process was characterized by the nationalization of a number of foreign enterprises.

Mining sector

The DRC is extremely rich in mineral resources, and its mining potential remains largely untapped. Its mineral resources include copper, cobalt, diamonds, gold, zinc, uranium, tin, silver, coal, manganese, tungsten, cadmium, and crude oil. Most mining is carried out by the largest state-owned company, the Générale des Carrières et des Mines du Congo (GECAMINES), which accounts for over 90 percent of total copper production, and the entire cobalt and zinc output. In the diamond sector, while the Société Minière de Bakwanga (MIBA), partly owned by the government, is responsible for the industrial mining of diamonds, individual prospectors account for some 60 percent of total diamond production.

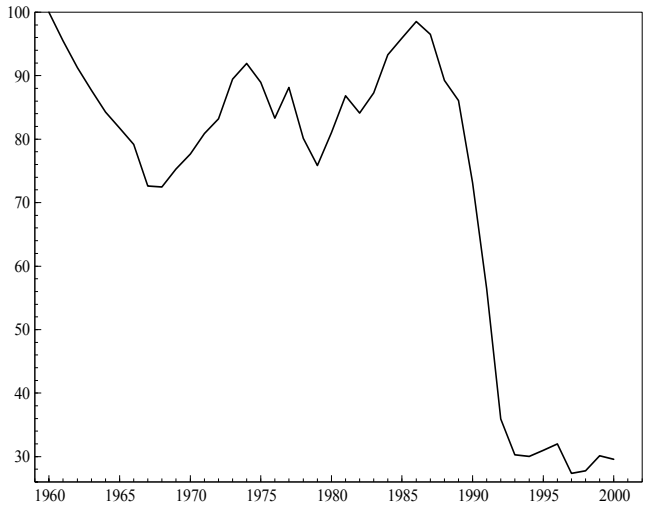
Beginning in the mid-1980s, the mining industry of the DRC entered a phase of steep decline (Figure 4):

- By the late 1990s, copper production by GECAMINES had declined to 5 percent of the peak mid-1980s output level of more than 500,000 tons, while cobalt production had fallen by 70 percent from pre-conflict levels.
- Production of zinc has virtually ceased, compared with a capacity of 200,000 tons.
- Gold production has practically come to a halt, compared with a capacity of 6 tons per year.
- Manganese production was discontinued at the Kisenge Mining Enterprise (EMK-MN), where capacity was 360,000 tons per year during the early 1980s.
- With the sharp fall in GECAMINES's output, diamonds became the single largest source of export earnings for the country. Because of frequent changes in marketing policies (including nationalization and the banning of foreigners from diamond-producing areas), large amounts of diamonds were exported through the parallel market. A monopoly to export artisanal diamonds granted in 2000 to a foreign company was rescinded in early 2001.

Reflecting its steep output slump, the mining sector's contributions to GDP and export earnings have been declining continuously. In the mid-1980s, mining accounted for almost one-fourth of real GDP and provided over 70 percent of export receipts; in 2000, while the mining sector remained the main source of export earnings (owing to diamond exports), it accounted for only about 6 percent of real GDP.

The mining sector has been facing a number of problems that have constrained its development. These include (a) a legal and regulatory framework not conducive to the development of the private sector; (b) serious transportation problems; and (c) chronic lack of investment.

Figure 4. Democratic Republic of the Congo: Mining Real Value Added (Index, 1960 = 100)



Sources: Congolese Authorities; and IMF staff estimates.

Transport sector

When the DRC gained its independence in 1960, it inherited a comprehensive transport system, including strategically interconnecting roads, rivers, and railways. The transport sector accounted on average for about 12 percent of real GDP in the 40-year period, 1960–2000. Given the large size of the country, its limited access to the sea, and the remoteness of its mineral deposits, the transport network is of vital importance to present and future economic activity. However, the sector's performance remains less than satisfactory (Figure 5), and difficulties in transportation constitute a major obstacle to the realization of the DRC's immense agroindustrial and mining potential.

Three public agencies—the Société Nationale des Chemins de Fer du Congo (SNCC), the Office National des Transports (ONATRA), and the Office des Routes—play a critical role because they are responsible for operating rail and river transport, and for building and maintaining the main highway network, respectively.

Since 1985, the financial situation of both ONATRA and SNCC has deteriorated sharply. Moreover, the services that they provide on the *Voie Nationale*, which combines the rail and water route from the Shaba mining area to the port of Matadi, have progressively declined. The poor performance of these two key agencies stems from a number of factors: the delay in adjusting tariffs in a highly inflationary environment; a decrease, or at best, stagnation in traffic; high operating costs; and chronic lack of maintenance.

In the late 1990s, the civil war took a toll on the transport sector and infrastructure collapsed. As a result, farmers have great difficulty in selling any surplus, while food prices in urban

centers are high. Interregional connections are often limited to minimal air transport; as a result the country has essentially broken down into a set of economic enclaves.

Figure 5. Democratic Republic of the Congo: Transport Real Value Added (Index, 1960 = 100)

Sources: Congolese authorities; and IMF staff estimates.

III. Theoretical Framework and Econometric Methodology

A. Long-Run Production Function

The theoretical framework is a production function that relates output per worker (Y) to physical capital per worker *(K)*:[6]

$$Y = Ae^{bt}K^{\alpha}, \tag{1}$$

where t is a time index; A is the fixed component of the total factor productivity (TFP), which is assumed to improve at a rate b; and α is the long-run contribution of capital per worker to output per worker.

Taking the natural logarithm of both sides of equation (1) yields:

$$y = a + bt + \alpha k, \tag{2}$$

where the lowercase variables correspond to the logs of the uppercase variables.

[6] For simplicity, the time subscripts are excluded.

Using equation (2), we estimate the long-run production function for the economy as a whole and for the key productive sectors (agriculture, mining, and transport). This allows us to analyze the sources of growth between the contributions of production factors and total factor productivity in Section IV.

Measurement of variables

Output. Output is measured by gross domestic product (GDP) at constant prices as published by the Central Bank of Congo. The sectoral output measures are given by the sectoral value added.

Labor inputs. Because employment series are not available, labor inputs are estimated by data on the economically active population (labor force) published by the International Labor Organization.[7] No adjustments for labor quality were introduced, due to lack of information on educational attainment,

Physical capital. As is the case in most developing countries, capital stock series are not readily available. Following a number of past studies,[8] we base the measure of capital on the *perpetual inventory* methodology. Having taken this route, two issues need to be dealt with: the initial capital stock and the rate of depreciation. We assume an initial capital-output ratio of 1.5 (a value of 1 was chosen for the agricultural sector) and the depreciation rate was set at 15 percent.[9] Based on these assumptions, the capital stock dynamics is as follows:[10]

---

[7] The use of the economically active population as labor inputs is common in most studies on developing countries.

[8] See, for instance, Nehru and Dhareshwar (1993); King and Levine (1994); Bosworth, Collins, and Chen (1995); Sacerdoti, Brunschwig, and Tang (1998); and Senhadji (1999).

[9] Those values for the capital-output ratio have been widely used in the literature (see, for example, Sacerdoti, Brunschwig, and Tang (1998); Beddies (1999); Vera-Martin (1999)). Mankiw, Romer and Weil (1992) found that the total capital-output ratio in developing countries is close to 1. Given the relatively high rate of depreciation, the impact of the initial stock of capital decreases rapidly and vanishes in less than seven years. The high rate of depreciation mainly reflects the widespread lack of maintenance and accelerated depreciation due to several conflicts. Beddies (1999) also chose a 15 percent rate for capital depreciation, while Vera-Martin (1999) pointed out that a depreciation rate of 10 to 15 percent does not significantly alter the econometric results.

[10] Our measure of capital stock in the agricultural sector is largely underestimated, primarily because of lack of data on most investments undertaken by farmers. Therefore, the econometric results for the agricultural sector should be interpreted with caution.

$$K_t - K_{t-1} = I_t - \delta K_{t-1}, \quad K_0 \text{ is given,} \tag{3}$$

where I_t is gross investment and δ the depreciation rate.

B. Econometric Methodology

To estimate the long-run production function, we use the Johansen and Juselius (1990) and Johansen (1988, 1991) methodology of cointegration, interpreted as representing a long-run equilibrium relationship. The method is based on the following vector error-correction model (VECM):

$$\Delta Z_t = \sum_{i=1}^{k-1} \Gamma_i \Delta Z_{t-i} + P_0 Z_{t-1} + \mu + \varepsilon_t \tag{4}$$

$$\Gamma_i = -\sum_{j=i+1}^{k} \Pi_j \quad \text{and} \quad P_0 = \sum_{i=1}^{k} \Pi_i - I, \tag{5}$$

where Z_t is a $p\times1$ vector time series, Γ_i is a $p\times p$ coefficient matrix, P_0 is a $p\times p$ matrix, μ is a $p\times1$ vector of deterministic variables, and ε_t is a vector of Gaussian error terms.

The existence of cointegration is based on the rank of P_0:

- If rank (P_0) = $r = p$ (full rank), the vector time series is stationary and no long-run relationship exists among the variables.
- If rank (P_0) = $r = 0$, there is no cointegrating vector and a VAR based purely on the first difference of Z_t is appropriate.
- If rank (P_0) = $r < p$, then the time series are nonstationary and there exist r cointegrating vectors. Under this condition, the matrix P_0 can be expressed as the product of two $p \times r$ matrices α and β both of full column rank:

$$P_0 = \alpha\beta', \tag{6}$$

with β' being the matrix of cointegrating vectors and α representing the error-correction coefficient (which reflects the speed of adjustment to the long-run equilibrium).

Two tests are commonly used to determine the number of cointegrating vectors: the trace test and the maximum-eigenvalue test.

Unit root test

Before turning to the tests for cointegration, one must determine the order of integration of the variables. Using the augmented Dickey-Fuller (ADF) test, the unit-root hypothesis is tested in the level of variables as well as in their first differences (Table 1 and 2). The null hypothesis is the presence of unit-root. The lag length in the ADF regression is selected striking a balance between the lag length chosen by the Akaike information criterion (AIC) and the *t*-test of the lags. Tables 1 and 2 show the unit root test results on the variables entering the overall and sectoral production functions. As can be seen, the null hypothesis that the level variables contain a unit root cannot be rejected at 5 percent or less.[11] All the variables were tested to be stationary in first differences. In light of these results, we conclude that all variables are integrated of the order of 1.

[11] The mining sectoral value added was found to have a unit root in the test with a deterministic linear time trend, but the presence of unit root was rejected at 5 percent in the test with a nonzero constant. As the graph of this variable clearly shows the presence of a linear trend, we go by the result of the first test.

Table 1: Testing for Unit Roots (ADF Test with Constant)

(Augmented Dickey-Fuller ADF(s) Test: $\Delta y = \mu + (\beta - 1)\, y_{t-1} + \sum_{i}^{s} \gamma \Delta y_{t-1} + \varepsilon_t$)

Variable	Level		Difference	
	ADF Statistic	Lag length	ADF Statistic	Lag length
Y	0.967	1	-2.379	0
K	-0.505	2	-1.705	1
y_a	-0.683	2	-3.947**	0
k_a	-2884	0	-4.498**	0
y_m	-3376 *	0	-6.093**	0
k_m	-2.504	0	-6.824**	0
y_r	-1.307	0	-5.655**	1
k_r	-1.839	0	-4.707**	0

Note: The asterisks, * and **, indicate significance at the 5 percent and 1 percent leves respectively. The critical values are -2.94 at the 5 percent significance level and -3.62 at the 1 percent significance level. The sample period is 1960-2000.Variables are as follows: output per worker (y) and physical capital per worker (k). The subscript "a" stands for agricultural sector, "m" for mining sector, and "r" for transport.

Table 2. Testing for Unit Roots (ADF Test with Linear Trend)

(Augmented Dickey-Fuller ADF(s) Test: $\Delta y = \mu + \alpha T + (\beta - 1)\, y_{t-1} + \sum_{i}^{s} \gamma \Delta y_{t-1} + \varepsilon_t$)

Variable	Level		Difference	
	ADF Statistic	Lag length	ADF Statistic	Lag length
Y	-1.593	1	-3.760**	4
K	-0.465	1	-3.945**	0
y_a	-0.318	2	-3.853**	1
k_a	-2.386	0	-4.415**	0
y_m	-2.187	0	-7.227**	0
k_m	-1.236	0	-5.799**	2
y_r	-3.472 *	1	-5.614**	1
k_r	-1.779	0	-4.672**	0

Note: The asterisks, * and **, indicate significance at the 5 percent and 1 percent levels respectively. The critical values are -2.94 at the 5 percent significance level and -3.62 at 1 percent significance level. The sample period is 1960–2000.Variables are as follows: output per worker (y) and physical capital per worker (k). The subscript "a" stands for agricultural sector, "m" for mining sector, and "r" for transport.

Cointegration results

The presence of a unit-root justifies the estimation of the production function within a *cointegration framework* (Tables 3–6). The Johansen's cointegration procedure starts with the determination of the length of the VAR version of equation (2). Since the cointegration test critically depends on the choice of the lag length, we base the lag selection on *the likelihood ratio test* of model reduction, moving from eight to four lags.[12] For the VAR estimated, different misspecification tests are also reported. Overall, no serious misspecification was detected, apart from the rejection of normality in one case. However, as

[12] Since models with different lag length must be nested and estimated over the same period for the *likelihood ratio test* to be performed and valid, all the VARs were estimated during the period, 1968–2000, the longest time span possible for eight lags.

pointed out by Gonsalo (1994) and Hubrich (1999), the Johansen procedure is not sensitive to non-normality errors.

Table 3. Cointegrating Tests Results

	Overall Function		Agricultural Sector		Mining Sector		Transport Sector	
Eigenvalue	0.492	0.186	0.344	0.255	0.608	0.261	0.574	0.114
Null hypothesis on rank = r	r = 0	r ≤ 1	r = 0	r ≤ 1	r = 0	r ≤ 1	r = 0	r ≤ 1
λ_{trace}	29.22*	6.81	23.65	9.71	40.88**	9.99	32.22**	3.99
λ_{max}	22.41*	6.81	13.94	9.71	30.90**	9.99	28.24**	3.99

Note: The estimation period is 1968-2000 and the asterisks, * and **, denote rejection at the 5 percent and 1 percent levels, respectively.

Table 4. Cointegrating Vectors and Adjustment Coefficients

	Y	*K*	*Constant*	*Trend*
Cointegrating vectors				
Aggregate function	1	-0.34	2.43	0.03
Mining sector	1	-1.51	-3.47	-0.06
Transport sector	1	-0.33	0.65	0.05
Adjustment coefficients				
Aggregate function	-0.29	-0.11		
Mining sector	0.09	0.16		
Transport sector	-1	-0.60		

Note: Since the capital coefficients are reported as an element of the cointegrating vector, their signs are negative.

Table 5. Properties of Cointegration VAR's Residuals

Diagnostic Tests	Aggregate Function		Mining Function		Transport Function	
	F-test value	p-value	F-test value	p-value	F-test value	p-value
AR	1.710	0.129	0.892	0.532	0.685	0.700
Normality	9.386	0.052	13.862	0.007**	1.311	0.859
ARCH	0.018	0.894	7.447	0.012*	0.249	0.624
Heteroscedasticity	0.318	0.989	0.339	0.985	----	-----

Note: The normality property is tested with χ^2. The asterisks, * and **, denote rejection at the 5 percent and 1 percent levels, respectively. There are not enough observations for a heteroscedasticity test for the mining sector.

Table 6. Significance Test of Cointegration Vectors

Cointegration Vectors	$\chi^2(1)$	*p*-Value for the Test Statistic
Aggregate production function		
Y	9.222	0.002**
K	6.015	0.014**
Trend	15.380	0.000**
Constant	8.762	0.003**
Transport production function		
y_r	21.067	0.000**
k_r	16.487	0.000**
Trend	16.675	0.000**
Constant	16.199	0.001**
Mining production function		
y_m	1.283	0.257
k_m	6.513	0.010*
Trend	1.360	0.243
Constant	1.4972	0.221

Note: The estimation period is 1968–2000. The asterisks, * and **, denote rejection at the 5 percent and 1 percent levels, respectively.

Results for testing the number of cointegrating vectors are reported, with both the trace and maximum eigenvalue statistics. In the trace test, the null hypothesis is that the number of cointegating vectors is less than or equal to r (r = 0 , 1); while in the maximum eigenvalue test, the alternative for r = 0 is r = 1. For the agricultural sector, we found no cointegrating

vector (precluding any long-run relationship), while in all other cases, both tests reject the null hypothesis of no cointegration vector at 5 percent or less in favor of one cointegating vector.[13] The results yield the following long-run production functions:

- Overall production function

$$y = -2.43 - 0.03t + 0.34k \text{; and} \tag{7}$$

- Transport sector production function

$$y_r = -0.65 - 0.05t + 0.33k_r . \tag{8}$$

As expected, the overall production function and the transport production function are characterized by decreasing returns to scale. Capital per worker is found to be a key determinant of long-term output per worker. The estimated coefficients for capital (0.34 for the overall function and 0.33 for the transport sector) have the right sign and are in line with the share of this factor in GDP (about 0.35 percent in developing countries). They are also consistent with the values (0.30 to 0.40) used in most growth studies. By comparison, Bosworth, Collins, and Chen (1995) obtained a coefficient of 0.4 on the capital term in the growth regression for developing countries, while Sacerdoti, Brunschwig, and Tang (1998) estimate the coefficient on physical capital at about 0.35 for West African countries.

The deterministic component of TFP growth is found to be negative (–3 percent for the overall function and –5 percent for the transport sector). This result shows, to some extent, how inappropriate economic policies implemented during the 40 years from 1960 to 2000 have negatively affected TFP. By comparison, Fischer (1993) estimates that productivity growth from 1961 to 1988 is about –5 percent a year for Haiti and Madagascar.

IV. SOURCES OF GROWTH

Having estimated the elasticity of output with respect to physical capital,[14] we now analyze the sources of growth, using a growth accounting exercise. The policy determinants of growth are also investigated.

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[13] For the mining sector, while the presence of cointegration cannot be rejected, the estimated elements of the vector are statistically insignificant (see Table 6). Therefore, no long-run production function was found for the mining sector

[14] The elasticities used for agriculture and mining are 0.28 and 0.60. These values are taken from another study (Sarel, 1997), since the available data do not allow meaningful estimates of elasticity for both sectors. Therefore, the results for the mining and agriculture sectors should be interpreted with caution.

A. Growth Accounting Exercise

Factor sources of growth

Table 7 and Figure 1 summarize the decomposition of the overall and sectoral outputs per worker into TFP growth and the contribution of physical capital per worker (defined as its share in output per worker multiplied by its growth rate). *At the macroeconomic level*, annual output per worker posted a negative average annual growth rate of -3.3 percent during 1960–2000. Negative TFP growth contributed to 60 percent of this decline, while the decline in physical capital per worker accounted for 40 percent.

At the sectoral level, in the agricultural sector, which experienced zero average annual TFP growth during 1960–2000, negative physical capital growth explained the negative growth of output per worker of 1.7 percent over this period. In the transport sector, TFP declines accounted for 92 percent of the negative growth rate of -6 percent of output per worker during the 40 years between 1960 and 2000. The mining sector recorded some TFP growth gains, but mining output per worker fell by an average 4.1 percent per year, owing to the rapid decline in physical capital per worker.

Sectoral contributions to overall growth

The bottom panel of Table 7 reports the sectoral contributions to GDP. The results indicate that the mining and transport sectors account for the negative real GDP growth of 0.3 percent per year during 1960–2000. Reflecting the negative trend in their outputs, the mining and transport shares in GDP have been completely eroded. The mining sector's share in GDP fell from 20 percent in 1960 to just 6 percent in 2000, while the transport sector's share declined from 18.5 percent in 1960 to a low of 3.7 percent in 2000.

Analysis across subperiods

The decomposition of sources of growth across the five subperiods (identified in the background subsection) reveals interesting patterns in the DRC's growth experience (Table 8). The subperiod, 1966–74, is the only one to experience a positive average growth rate, 2.9 percent, with physical capital per worker and TFP contributing equally. During the subperiod, 1975–82, notwithstanding the positive contribution of physical capital per worker of 1 percentage point (the second highest of the five subperiods), output per worker still declined by 3.8 percent, reflecting the sharp drop in TFP. The reason is that a series of so-called prestigious projects (mainly white elephants) implemented during this subperiod had damaging impacts on TFP. As can be seen in Table 8, physical capital per worker in the key sectors of mining and transport sharply fell at the same time, as these white elephants pulled away resources from both sectors. Finally, the last subperiod (1990–2000) witnesses the largest decline in output per worker and in both physical capital and TFP, reflecting the damaging effects of hyperinflation, as well as of armed conflicts (since 1998).

Table 7. Democratic Republic of the Congo: Sources of Growth by Factor Accumulation and Sectors, 1960–2000

(Annual percentage change)

Period	Output per Worker	Contribution of:	
		Physical Capital	Total Factor Productivity
1960–2000	-3.3	-1.3	-2.0
1960–65	-4.4	-3.7	-0.7
1966–74	2.9	1.6	1.3
1975–82	-3.8	1.0	-4.8
1983–89	-1.1	-1.9	0.8
1990–2000	-8.8	-3.9	-4.9

Period	Output	Contribution of:			
		Agriculture	Mining	Transportation	Other
1960–2000	-0.3	0.2	-0.4	-0.4	0.3
1960–65	0.5	-2.0	-0.7	-1.3	4.5
1966–74	5.1	0.9	0.2	0.7	3.3
1975–82	-1.6	0.6	-0.2	-0.9	-1.1
1983–89	1.9	1.5	0.1	0.0	0.3
1990–2000	-5.5	-0.4	-1.0	-0.8	-3.3

Table 8. Democratic Republic of the Congo: Sources of Growth in Mining and Transport, 1960–2000
(Annual percentage change)

Sectors and Period	Output per Worker	Contribution of:	
		Physical Capital	Factor Productivity
Agriculture			
1960–2000	-1.7	-1.7	0.0
1960–65	-9.6	-5.3	-4.3
1966–74	0.9	-2.8	3.7
1975–82	-0.1	-1.6	1.5
1983–89	0.8	1.1	-0.3
1990–2000	-2.9	-1.0	-1.9
Mining			
1960–2000	-4.1	-6.8	2.7
1960–65	-6.0	-0.1	-5.9
1966–74	-18.7	-15.9	-2.8
1975–82	-2.2	-9.7	7.5
1983–89	0.7	-5.3	6.0
1990–2000	4.2	-1.1	5.3
Transportation			
1960–2000	-6.2	-0.5	-5.7
1960–65	-5.0	-0.6	-4.4
1966–74	-2.1	-1.7	-0.4
1975–82	-13.2	-4.7	-8.5
1983–89	3.0	1.2	1.8
1990–2000	-11.0	2.4	-13.4

B. Policy Determinants of Growth

We investigate the role of policy variables and other variables as determinants of growth, using a modified version of the neoclassical growth model applied by Ghura and Hadjimichael (1996) and Calamitsis, Basu, and Ghura (1999) to sub-Saharan Africa. The growth equation estimated takes the following form:[15]

$$\Delta y_t = \gamma_1 \ln(I_p / Y)_t + \gamma_2 \ln(I_g / Y)_t + \gamma_3 Exrp_t + \gamma_4 DEF_t + \gamma_5 TOT_t + \gamma_6 Dwar_t + \nu_t, \qquad (9)$$

where Δy is the per capita output growth; I_p / Y and I_g / Y are the ratios of private and government investment to GDP; *Exrp* is the parallel market exchange rate premium; DEF is

[15] Owing to data constraints, several variables found in the growth literature to have a strong influence on economic growth have not been included.

the ratio of the central government budget deficit to GDP; *TOT* is the growth rate of the external terms of trade; and *Dwar* is a dummy variable for war and conflicts.

Equation (4) is estimated using annual data for the period, 1960–2000. The regression results are summarized in Table 9. The main results are as follows:

- The private investment-GDP ratio exerts a large positive effect on economic growth. The estimated coefficients are slightly higher than the ones reported by Calamitsis, Basu, and Ghura (1999) for sub-Saharan Africa. The impact of private investment does not change much when other variables are included in the regression.

- The effect of government investment is negative and significant in two of the three specifications, supporting the fact that public capital was mostly invested in white elephants and unproductive projects.

- The policy environment seems to have significantly influenced growth in the DRC. The estimated coefficient on the budget deficit ratio and the parallel market rate premium are negative and significant, confirming the view that hyperinflation and uncontrolled budget deficits have undermined the DRC's growth performance.

- The estimated effect of changes in the terms of trade is positive and statistically significant. The coefficient on the dummy variable indicating conflicts and wars has a negative and highly significant effect on growth, supporting the notion that political turmoil and conflicts have played a crucial role in the DRC's poor growth performance.

Table 9. Democratic Republic of the Congo: Estimates of the Neoclassical Growth Equation 1/ 2/

Explanatory variables		(1)	(2)	(3)
Conventional Variables				
$Ln(I_p/Y)$	Private investment/GDP ratio	0.043[a]	0.047[a]	0.036[b]
		(2.69)	(3.35)	(2.42)
$Ln(I_G/Y)$	Government investment/GDP ratio	-0.009	-0.018[a]	-0.018[a]
		(-1.44)	(-3.10)	(-3.32)
Policy-related variables				
Exrp	Parallel market exchange rate premium		-1.6E-04[b]	-1.6.E-04[a]
			(-2.22)	(-2.84)
DEF	Central government budget deficit		-0.004[a]	-0.003[a]
			(-3.17)	(-3.44)
Other explanatory variables				
TOT_g	Terms of trade growth			7.9E-04[c]
				(1.89)
D_{war}	Dummy variable for conflicts and wars			-0.049[a]
				(-3.41)

1/ The estimation period is 1960–2000; a, b, and c denote statistical significance at 0.01, 0.05, and 0.10 levels, respectively. The numbers in parentheses below the estimated coefficients are the t-values.
2/ The diagnostic tests for equation (3) are as follows: Testing for error autocorrelation from lags one to two F (2, 32) = 0.3963 [0.6760]; normality χ^2 (2) = 3.8682 [0.1446]; autoregressive conditional heteroscedasticity (ARCH) F (1, 32) = 0.0291 [0.8656]; heteroscedasticity errors F (11,22) = 0.4578 [0.9098].

V. Policy Reforms and Medium-Term Growth Prospects

A large number of theoretical and empirical studies have shown that improving macroeconomic and structural policies positively affects economic growth by increasing investment and productivity growth.[16] The DRC's medium-term growth prospects, therefore, will be assessed in light of recent policy reforms to lay the foundation for economic growth.

A. Macroeconomic and Structural Reforms

The implementation of bold measures under the EIP marked a turnaround in the conduct of economic policy that has produced significant results. With the restoration of the independence of the central bank, the vicious circle of hyperinflation and currency depreciation has been broken. Inflation sharply decelerated from an annual rate of

[16] See, for example, and Wetsel Easterly (1989); Ghura and Hadjimichael (1996); and Calamitsis, Basu, and Ghura (1999).

511 percent in 2000 to 15 percent in 2002. The sharp decline in inflation has led to the stabilization of the exchange rate after the introduction of a floating exchange rate system at end-May 2001. Important progress was also made in strengthening public finances via a return to normal budgetary procedures.

Far-reaching structural reforms are also being implemented, with a view to creating an environment conducive to private sector development and economic recovery. The scope of the reforms encompasses a wide range of areas, including public sector , the financial sector, mining, agriculture, forestry and environment, the rehabilitation of key infrastructures (transportation, telecommunications, water, and electricity), the social sectors, institutional capacity building, the judicial and regulatory environment, and the promotion of good governance and anticorruption measures.[17]

B. Medium-Term Growth Prospects

Sound macroeconomic policies and the ongoing far-reaching structural reforms have started to have a positive effect on growth through improved resource allocation.[18] The DRC's growth prospects are also enhanced by its untapped potential in the mining, agriculture, forestry, and energy sectors. Moreover, growth should rebound strongly and quickly (a pattern observed in other post-conflict cases), since the country is starting from a very low base.

Based on the above econometric results, this section analyzes the credibility of the program's growth targets from 2002–05, discussing the feasibility of the implicit productivity growth rates underpinning these real GDP growth projections. It also assesses how fast the country can make up for the ground lost during the 40-year period from 1960–2000.

Assessing the credibility of the program's medium-term growth prospects

With the estimated production function derived in Section III, growth forecasts are based on projections of labor force, capital stock (based on investment and the perpetual inventory methodology), and productivity growth rates (reflecting ongoing economic reforms).

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[17] More details on the DRC's policy reform can be found in IMF country reports and the authorities' memorandum of economic and financial policy posted on the IMF's external web site (www.imf.org).

[18] As pointed out in Section I, in 2002, for the first time in 13 years, real GDP growth is estimated to have been positive, at about 3 percent.

Using this projection methodology[19] and assuming that the labor force will grow at the population growth rate, that is, 3 percent per year, the study finds that a "Solow residual"[20] growth rate of 2.5 percent implicitly underpins the program's real GDP average growth rate of about 5 percent[21] and the average investment-to-GDP ratio of 16 percent from 2002–05. The whole Solow residual should not be ascribed to TFP growth, because it incorporates a "catch-up" factor that is typical for a post-conflict country.[22] Unfortunately, it is not easy to estimate the latter. One indirect estimation would be to estimate the TFP growth in a normal period and argue that one would expect at least this TFP growth to be achieved in the forecast period, mainly because of policy implementation. Using this procedure, we estimate TFP growth at 1.3 percent, which implies a catch-up factor of 1.2 percent. While the 1.3 percent TFP growth is higher than those experienced in industrial, Latin American, and African countries, it is well below East Asian TFP growth rates (Table 10). In sum, if the actual investment rate were to fall below 16 percent of GDP over 2002–05, the average economic growth rate of 5 percent would be difficult to achieve, because it would imply unrealistic TFP growth rates.

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[19] It is expected that with the return of peace and the normal functioning of the economy, the capital depreciation rate will decline to 5 percent, beginning in 2002, from the 15 percent assumed earlier. With a 10 percent depreciation rate, the Solow residual growth will be about 1.5 percentage points higher.

[20] The Solow residual is the part of output growth that is not explained by changes in inputs.

[21] The annual economic growth rate in post-conflict countries has averaged 5 percent in the five years immediately after conflict, and 3 percent in per capita terms. However, the lack of data on productivity growth in post-conflict countries precludes any assessment of our estimates of the Solow residual and productivity growth from a post-conflict country standpoint.

[22] A significant part of the catch-up factor is due to intensified capacity utilization in the post-conflict period.

Table 10. Sources of Growth in Selected Countries and Regions, 1986–92

Regions/Countries	Output per Worker	Contribution of: Physical Capital	Factor Productivity
Regions			
Industrial countries	1.5	0.7	0.8
Africa	-0.4	-0.5	0.1
Latin America	-0.6	0.0	-0.6
East Asia (excluding China)	5.1	2.6	2.5
South Asia	2.9	1.2	1.7
East Asian countries			
China	6.2	3.1	3.1
Korea	6.6	3.9	2.7
Malaysia	5.4	1.9	3.5
Singapore	7.4	2.6	4.6
Thailand	8.3	3.2	4.8
Taiwan Province of China	5.9	2.8	3.1

Source: Bosworth, Collins, and Chen (1995).

Assessing the time required to recoup the lost ground

As indicated in Section II, output per capita and real GDP have followed a steep decline, especially since 1990. Real GDP had risen to 150 percent of its 1960 level by 1990, only to decline to about 80 percent of its 1960 level by 2001. At the same time, with 3 percent annual growth of the population, real GDP per capita fell to 60 percent of its 1960 level in 1990, and further to 25 percent of its 1960 level in 2001.

An interesting question is how many years, beginning in 2002, would it take both aggregates to reach their 1960 and 1990 levels, if the projected 5 percent real GDP growth were to continue beyond 2005 for several decades. We calculate that it would take four years for real GDP to reach its 1960 level and 13 years to return to its 1990 level. *Assuming that the population continues to grow at an annual rate of 3 percent, reaching the 1960 real GDP per capita level would take 70 years, while the 1990 level would be attained in 45 years. These time frames highlight the DRC's disappointing economic performance in the 40 years from 1960 to 2000.*

VI. Conclusions and Policy Implications

This paper has examined the sources of growth in the DRC and assessed the medium-term growth prospects for the country. It concludes that poor economic policies and conflicts, through their effects on total factor productivity and the investment rate, significantly hurt the country's economic performance from 1960 to 2000. However, the study also demonstrates that the right policies are being put in place to pave the way for growth restoration by raising the TFP growth and investment rate.

In light of the policies being implemented and investment rates envisaged under the government's economic program, an average growth rate of about 5 percent is estimated to be achievable over the next four years, 2002–05.

The main findings of the paper can be summarized as follows:

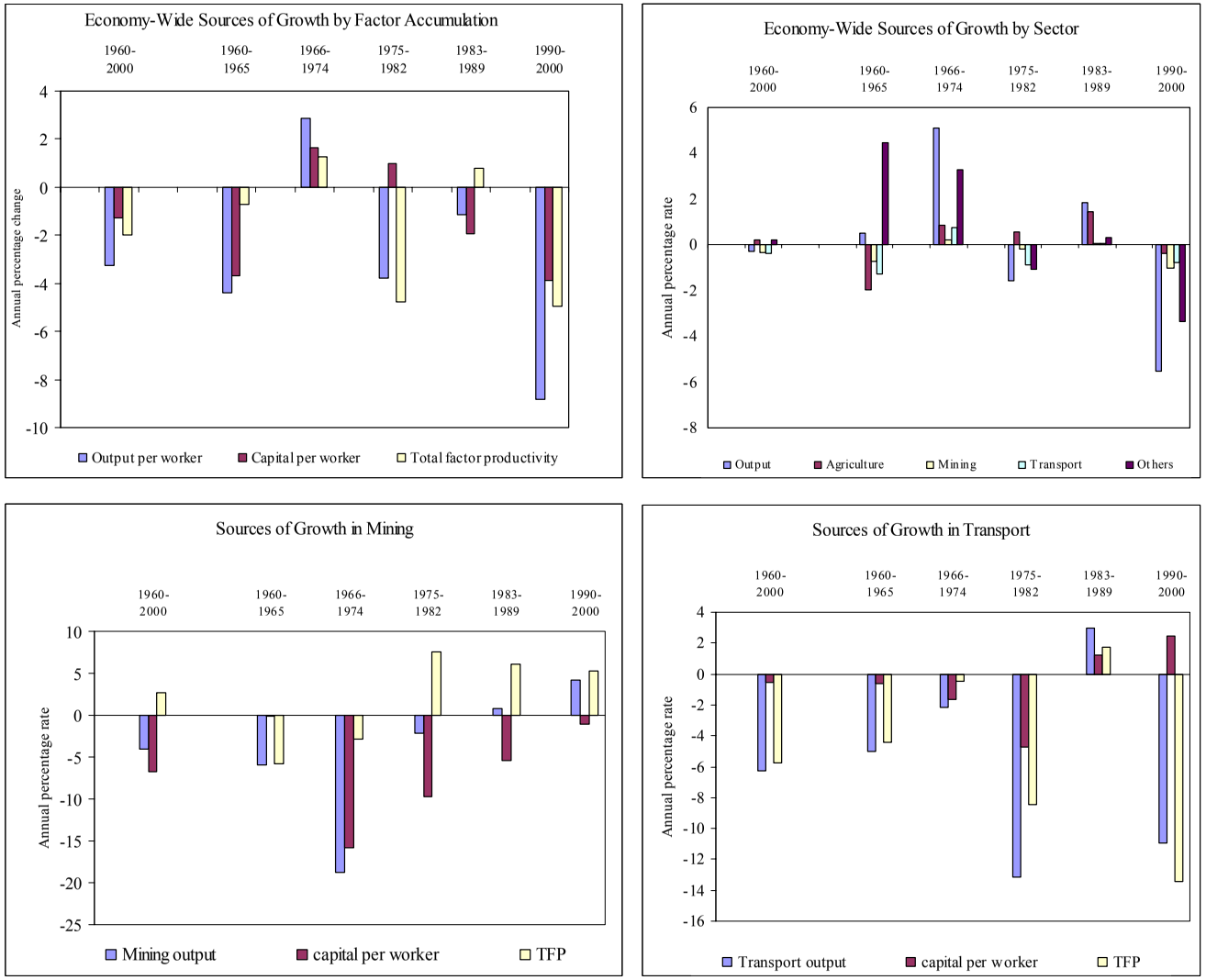
- Using the cointegration procedure, the critical technology parameter—the average share of physical capital per worker in output per worker—of the long-run production function is estimated at 0.34 for the whole economy and 0.33 for the transport sector. No cointegration relationship between output and capital was found for the mining and agricultural sectors.

- Using a growth-accounting framework from 1960 to 2000, the findings on the TFP and factor accumulation contributions to output growth are as follows: first, at the macroeconomic level, negative TFP growth contributed to 60 percent of the negative average annual growth rate of 3.3 percent during the 40-year period from 1960 to 2000, while the decline in physical capital per worker accounted for 40 percent. Second, at the sectoral level, in the agricultural sector, which experienced zero average annual TFP growth during the period 1960–2000, negative physical capital growth explained the negative growth of output per worker of 1.7 percent over this period. In the transport sector, TFP declines accounted for 92 percent of the negative 6 percent growth of output per worker from 1960 to 2000. The mining sector recorded some TFP growth gains, but mining output per worker fell by an average 4.1 percent per year, owing to the rapid decline in physical capital per worker.

- In analyzing the determinants of the DRC's economic growth from 1960 to 2000, our regression results show that private investment has a large positive impact, while the effect of government investment has been negative, supporting the view that public capital was mostly invested in unproductive projects. High inflation rates (as reflected by a high parallel market exchange rate premium) and large budgetary deficits have also exerted a negative impact on growth. Finally, political turmoil, conflicts, and war have contributed significantly to the poor growth performance.

- In assessing the DRC's medium-term growth prospects, we note that an economic turnaround has begun, with real GDP projected to be growing by 5 percent a year over the next four years. Assuming that the population continues to grow at an annual rate of 3 percent, reaching the 1960 real GDP per capita level would take 70 years, while the 1990 level would be attained in 45 years. These estimates clearly show that the DRC has a long way to go to recoup the ground lost during the 40-year period from 1960 to 2000. They also illustrate how both the creation of an enabling environment for private investment, as well as a coordinated, sustained, and comprehensive foreign aid, are necessary conditions to make a real dent in the DRC's widespread poverty

Figure 6. Democratic Republic of the Congo: Growth Accounting, 1960–2000



Sources: Congolese authorities; and IMF staff estimates.

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