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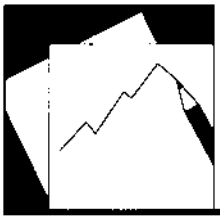

IMF Working Paper

Economic Growth and Total Factor Productivity in Niger

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and
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African Department

Economic Growth and Total Factor Productivity in Niger[1]

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Abstract

This paper investigates empirically the sources of aggregate output growth and the determinants of total factor productivity (TFP) in Niger between 1963 and 2003. A growth accounting analysis indicates that the erosion in output per capita over the sample period is due to the negative growth of both TFP and physical capital per capita. Sound macroeconomic policies, supported by official development assistance and structural reforms, are found to be key to raising TFP growth.

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Contents Page

I. INTRODUCTION

Niger's economic growth over the past several decades has been relatively modest except for a brief period during the uranium boom years of 1979-82 when economic activity intensified. When growth came to an abrupt end with the collapse of the world uranium market, the economy fell into a prolonged period of recession. After the 1994 devaluation of the CFA franc and the resulting improvement in external competitiveness, however, real GDP growth again turned positive, helped by favorable weather.[2] Today, after recurrent droughts, social and political unrest—including several military coups—and repeated shortfalls in foreign financial assistance, the country continues to have difficulty sustaining growth.

The literature on the sources of economic growth has burgeoned since the works of Young (1992) and Krugman (1994). Krugman argued that the growth in East Asian economies was unsustainable because it was largely driven by capital accumulation and improving labor quality rather than gains in productivity. From this perspective, identifying the sources of growth is crucial to a country's long-term economic prospects. The ability to correctly predict growth sources takes on added significance for Niger, given its fragile economic outlook.

This paper investigates the sources of growth and the determinants of total factor productivity (TFP) growth in Niger during 1963-2003. It first estimates a Cobb-Douglas production function by testing cointegration between real GDP per capita and physical capital per capita. It then conducts a growth accounting analysis, disaggregating output growth in terms of the accumulation of factors of production and the efficiency with which these factors are used. The determinants of the derived TFP growth are investigated through standard regression analysis.

The paper models the impact of macroeconomic factors on a low-income country that underwent major supply shocks over the sample period. It pays attention to issues that are central in modeling production functions: economic theory, data measurement, returns to scale, parameter constancy, nonstationarity and cointegration, exogeneity, and policy implications. Rather than the share of physical capital in aggregate output being imposed a priori, it is estimated econometrically. Using multivariate cointegration analysis both guards against the potential endogeneity of the explanatory variable and corrects for the likely autocorrelation of the error term.

The results confirm that there is a long-run stable relationship between output per capita and physical capital per capita over the sample period. Recursive estimates show that the capital share of income, estimated at about 0.35, remained relatively stable from the mid-1980s through the early 2000s. We also find that the disappointing growth in output per capita during the sample period covered is due to the negative growth of both TFP and physical capital per capita. Sound macroeconomic policies, supported by official development assistance and structural reforms, will be key to growing TFP and raising living standards in Niger.

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[2] Niger is a member of the franc zone. The CFA franc is issued by the Banque des Etats de l'Afrique de l'Ouest (BCEAO). The CFA franc was created in 1945 with a fixed exchange rate vis-à-vis the French franc. That rate was changed only twice—in 1948 and in 1994. Since the demise of the French franc in January 1999, the CFA franc has been pegged to the euro.

II. Political and Economic Background

Economic developments since the country gained independence in 1960 can be divided into four distinct periods. From 1963 to 1978, the primary sector (agriculture, livestock, forestry and fishery) contributed more than half of total value added; mining accounted for about 7 percent, and per capita real GDP growth averaged 0.8 percent a year. During the uranium boom years of 1979-82, per capita real GDP increased by about 2.5 percent per year, and the mining sector almost doubled its contribution, reaching 13 percent. When the world market for uranium collapsed in the mid-1980s, the economy fell into recession; per capita real GDP declined on average by 3.4 percent a year from 1983 through 1993. Economic activity began to recover somewhat when the CFA franc was devalued in 1994; annual growth of per capita real GDP was 0.4 percent from 1994 to 2003.

Between 1960 and 1978, agriculture was by far the most important sector of the economy. But agriculture is vulnerable to the vagaries of the weather, and the six-year drought from 1968 to 1974 severely restricted economic growth. Still, the government largely succeeded in controlling spending and kept annual inflation to an average of 8 percent.

Though uranium production started in 1971, it only gained prominence in 1979-82; annual growth of aggregate real GDP was 5.1 percent for that period. At the same time, as Niger's budgetary revenue increased significantly, capital spending on major infrastructure projects throughout the country accelerated. The overall budget deficit shot up from 3.2 percent of GDP in 1978 to 10.8 percent in 1981, helping push inflation to almost 25 percent.

The period 1983-93, which saw the collapse of the world uranium market, was arguably the most difficult in Niger's history. Aggregate real GDP declined by 0.2 percent per year. The country was facing growing macroeconomic imbalances as the terms of trade deteriorated, and it was losing competitiveness due to currency overvaluation, recurrent droughts, and inefficient economic management. Acute political instability, including a Touareg rebellion in the North and massive social unrest elsewhere, further worsened the economic situation (Box 1).

As Niger's competitiveness eroded, the few light industrial and manufacturing enterprises all but shut down, while foreign-financed investment slowed considerably. The overall budget deficit (on a commitment basis and excluding grants) deteriorated, and there was a buildup of domestic and external payments arrears. Over the period 1983-93, the external current account recorded some improvement—averaging -2.5 percent of GDP annually compared to more than -11 percent previously—but at the expense of huge reductions in the imports of much-needed growth-sustaining capital goods, reflecting severe cuts in public sector investment.

The devaluation of the CFA franc on January 12, 1994, gave Niger an opportunity to improve its external competitiveness and put the economy back on a path to sustained growth. The realignment of the exchange rate from CFAF 50 to CFAF 100 per French franc was part of a comprehensive external adjustment strategy. The real effective exchange rate, which was estimated to be overvalued by 25-30 percent in 1991, depreciated by 30 percent. Helped by above-average rainfall and a record agricultural production, the devaluation spurred agricultural exports; that year real growth was 4 percent. However, inflation rose substantially in 1994-95 and the government's financial difficulties persisted. During 1994-98 real GDP

grew by 4.6 percent annually and inflation fell to 4.5 percent in 1998 from 35 percent in 1994. The economy relied increasingly on its primary sector, which contributed 40 percent to GDP.

Box 1. Key Political Events Since Independence

1960	Niger becomes independent; parliament elects Hamani Diori president.
1968-73	Severe drought devastates Niger's livestock and crop production.
1974	Hamani Diori overthrown in military coup led by Lt-Col. Seyni Kountche.
1987	Ali Seybou, the armed forces chief of staff, succeeds Kountche, upon Kountche's death.
1989	A new constitution brings Niger back to civilian rule but under a one-party system; Seybou re-elected president.
Ban on parties lifted	
1990	Seybou legalizes opposition parties after a wave of strikes and demonstrations.
1990	Touareg people in the north rebel.
1991 July	Constitutional conference strips Seybou of his powers and sets up a transitional government under Andre Salifou.
1992	New constitution allowing multiparty elections ratified.
1993	Ousmane Mahamane elected president; his coalition, the Alliance of the Forces of Change, wins a majority of seats in parliament.
1995	Ceasefire between the government and the Touareg's Revolutionary Armed Forces of the Sahara comes into effect.
More coups	
1996 January	Ousmane ousted in a coup led by Col. Ibrahim Mainassara, who bans political parties.
1996 May	New constitution giving the president increased powers approved in a referendum; ban on political parties lifted.
1996 July	Mainassara wins presidential election.
1997	The Democratic Renewal Front, a hard-line Touareg group, signs peace accord with government.
1999	Maj. Daouda Wanke assumes power after the assassination of Mainassara by his bodyguards.
1999	New constitution restoring the balance between the legislative and executive branches of power approved in a referendum.
1999	Mamadou Tandja elected president and his party, the National Movement for the Society in Development, wins majority of seats in parliament.
2002	Soldiers stage mutinies in the east and in the capital, demanding better conditions and the payment of wage arrears; the army puts down the rebellions.
National Strategy	
2003	Government, civil society and political parties adopt a National Strategy for the Prevention and Management of Conflicts in an effort to prevent a resurgence of the internal conflicts that have adversely affected Niger's stability.

Source: http://news.bbc.co.uk/1/hi/world/africa/country-profiles.

Though real GDP growth once more turned negative, on account of a prolonged drought in 1999-2000, it rebounded nicely during 2001-03, averaging 5.1 percent a year. This strong growth performance reflected not only favorable weather conditions but also a number of measures to promote growth, including improved fiscal management and performance, and higher capital expenditures on infrastructure (see World Bank, 2005). Reflecting the import of capital goods financed by aid flows, the current account deficit (excluding official transfers) widened to 7.8 percent of GDP in 2003 from 6.5 percent in 2001. Prudent monetary and fiscal policies and better output growth pushed 12-month inflation down from 4.7 percent at end-

2000 to -1.5 percent at end-2003. Nevertheless, Niger has had only modest success in economic diversification. Average growth is below the level required for poverty reduction, particularly in view of the increasing annual rate of population growth (2.7 percent for 1964-82 and 3.3 percent for 1983-2003).

III. THEORY, METHODOLOGY, AND DATA

Production Function

The point of departure here is the standard Cobb-Douglas aggregate production function linking output to factor inputs (capital and labor) and productivity (along the lines of the neoclassical Solow-Swan model; see, for instance, Barro and Sala-i-Martin, 2004):

$$Y_t = A_0 \, e^{bt} \, K_t^{\alpha} L_t^{1-\alpha} \qquad (1)$$

where t is a time index, Y is real GDP, K is real capital stock, L is total employment, α is the contribution of capital to output, 1-α is the contribution of labor, and the expression $A_0 \, e^{bt}$ is TFP. TFP— technological progress and other elements that affect the efficiency of the production process— measures the shift in the production function at given levels of capital and labor. The fixed component of TFP (A_0) is assumed to grow at a rate b. Dividing by L and taking the natural logarithms of the left and right sides of equation (1) yields:

$$y_t = a + bt + \alpha k_t \qquad (2)$$

where the lowercase variables y and k denote, respectively, the natural logarithms of output and physical capital in per capita terms. For estimation purposes, a (the natural logarithm of A_0) is unobservable and will be captured through the residuals of equation (2). This production function is often used to approximate the production possibilities of the economy because it has many properties that are convenient to work with, such as perfect competition, constant returns to scale (CRTS), and constant factor income shares.

Data used in this exercise are from the IMF's *World Economic Outlook* (WEO) and the World Bank's *World Development Indicators* (WDI) databases. Estimates of the capital stock are computed using the perpetual inventory method and assuming a depreciation rate of 5 percent and a capital-output ratio of 1.5 in the base year, 1963. Given the severe limitations of data for Niger, population is used as a proxy for the labor force. Figures 1 and 2 display these series.

To estimate the production function, we apply the Johansen (1988) multivariate cointegration procedure to the output per capita and physical stock per capita series over the period 1963-2003. Both series are indeed nonstationary, as suggested by the augmented Dickey-Fuller unit root test. Thus, there will be a long-run relationship between output per capita and physical stock per capita only if they are cointegrated. The finding of cointegration will imply that there is a stable, long-run equilibrium relationship between the two series in the sense that they tend to move together in the long run rather than wandering away from each other. While the Johansen cointegration test takes into account the nonstationarity of the data, it does not assume a priori that the physical stock is exogenous. The potential endogeneity of factor inputs

has often been advanced in the growth literature as an argument against estimating production functions to determine the share of physical capital (see, for instance, Barro, 1999).

Growth Accounting and the Importance of TFP Growth

After estimating the parameter α in equation (2), we can decompose output growth into the contribution of the increases in labor and capital and the contribution of TFP. Assuming that the production function exhibits CRTS, and that goods and factor markets are competitive, we can write the growth rate of output ($\Delta Y/Y$) as:

$$\Delta Y/Y = \alpha\, \Delta K/K + (1- \alpha)\, \Delta L/L + \Delta A/A \qquad (3)$$

The only term that cannot be measured directly in equation (3) is the growth rate of TFP ($\Delta A/A$). This is measured indirectly by reorganizing equation (3) to get:

$$\Delta A/A = \Delta Y/Y - (\alpha\, \Delta K/K + (1- \alpha)\, \Delta L/L) \qquad (4)$$

Hence, TFP growth is a residual—a "measure of our ignorance" (Abramowitz, 1956). It is the part that remains after subtracting from income growth the weighted rate of growth of factor inputs, where the weights are the corresponding input shares. The decomposition of growth into input and TFP contribution does not identify policy implications because it does not provide the factors behind the estimated TFP growth rates. A complementary question, then, is the effect of a policy outcome like inflation or the fiscal deficit on capital accumulation or TFP growth. In searching for a stable relation between the actual growth rates of output and various variables suggested by the old and new economic theories, most studies have complemented growth accounting exercises with growth regressions for a country or group of countries.

The neoclassical model implies that steady-state growth and hence the possibility of raising living standards over time is due to TFP growth. Indeed, assuming that the key parameter (α) of the Solow-Swan model is stable over time (as is tested and confirmed through recursive estimates of equation (2)), for *sustained* increases in real wages (W/P) and hence living standards in Niger, labor productivity (Y/L) would have to increase.[3] Since the growth rate of capital per unit of labor is zero in the steady state (Solow, 1956), the growth accounting formula (equation (3)) can be written simply in terms of the labor productivity growth rate:

$$\Delta(Y/L) / (Y/L) = \Delta A/A \qquad (5)$$

Because of the crucial importance of raising economic growth and living standards over time, we investigate the determinants of TFP growth in Niger. Equation (5) holds in the steady state.

[3] With perfect competition, factor inputs are paid their marginal products and the labor's share of income connects the real wage (W/P) and labor productivity (Y/L): $(1 - \alpha) = W*L/P*Y = (W/P)/(Y/L)$. Hence, if labor's share of income is constant, the growth rate of real wages must exactly equal the growth rate of labor productivity.

Hence, a more general equation that includes the growth rate of per capita physical capital is estimated in the empirical section of this paper.

Figure 1. Niger : Output, Capital, and Labor Force (in natural logarithms)

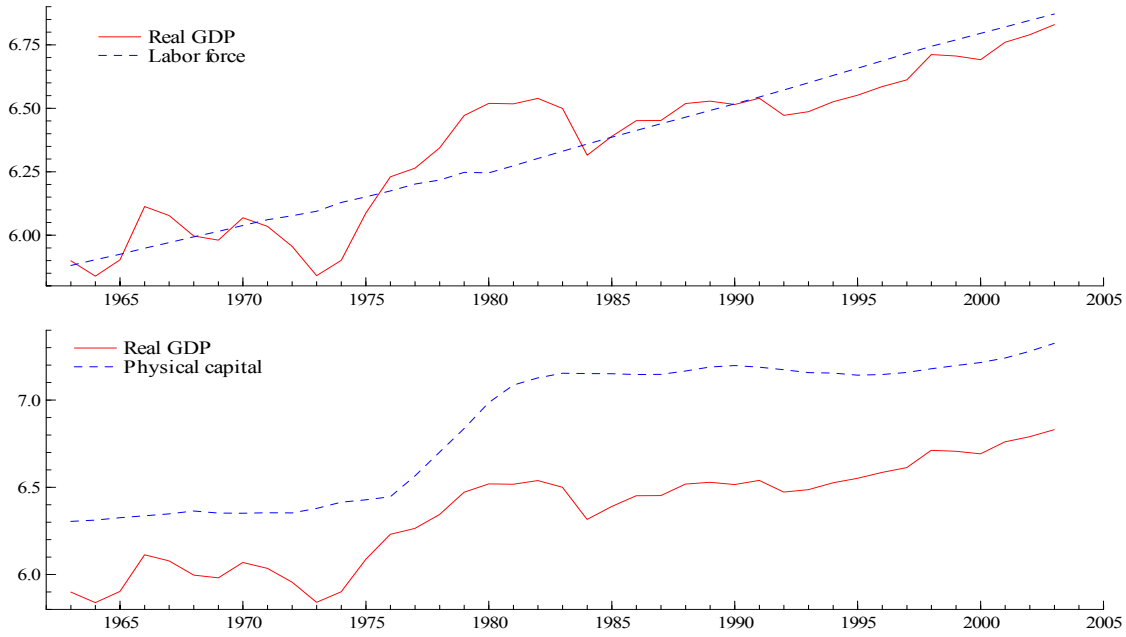
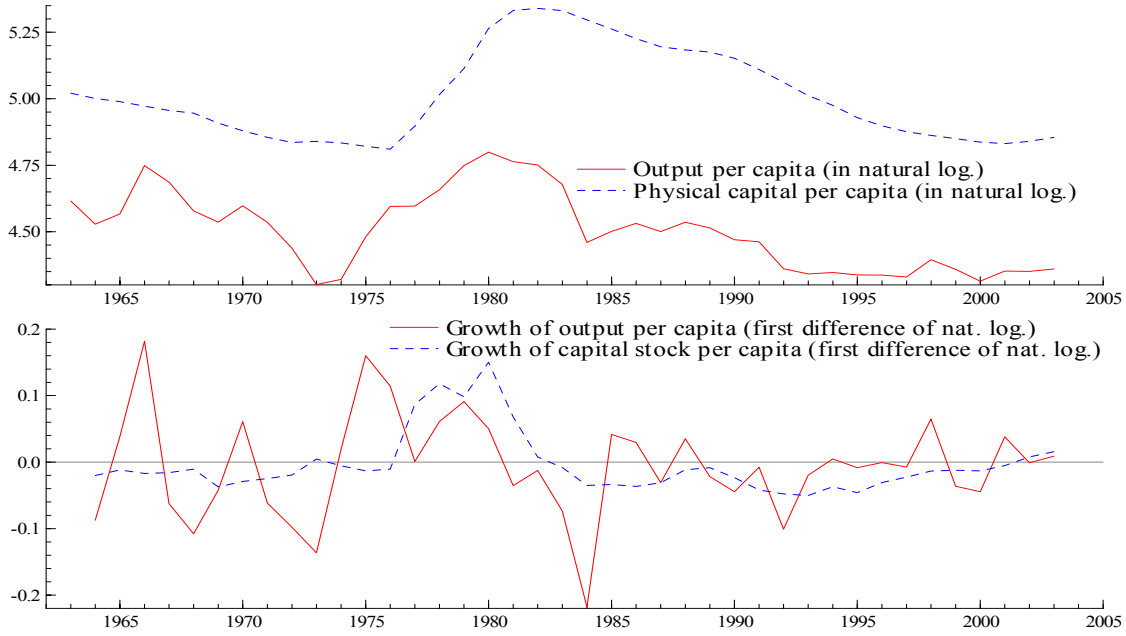


Figure 2. Niger: Output per Capita and Physical Capital per Capita



The Determinants of Per Capita GDP and TFP Growth

Recent developments in growth theory have stressed the importance of good institutions (North, 1990; Hall and Jones, 1999; and Acemoglu, Johnson, and Robinson, 2001) and sound policies in creating an environment that fosters economic development through accumulation

of factors of production and efficient use of resources. Empirical work exploring the impact of policy, institutional, or exogenous variables on a number of African countries includes, among others, Ghura and Hadjimichael (1996), Elbadawi and Ndulu (1996), Sachs and Warner (1997), Collier and Gunning (1999), Wane (2004), and Pattillo, Gupta, and Carey (2005). The explanatory variables most often proposed in empirical studies as determinants of TFP growth are the following:

- **Government size and fiscal policy**. A government with high expenditures as a percentage of GDP must take in high revenues from taxation of households and firms, which adversely affects the efficiency of economic activity.[4] In addition to the direct impact of expenditures and taxes, the stance of fiscal policy, as measured by the fiscal deficit-to-GDP ratio, can affect TFP growth through its impact on inflation and macroeconomic stability. In this study, we use government consumption as a percentage of GDP as a measure of the government burden and the drain the government may represent on the private sector. The fiscal stance is measured by the overall fiscal balance (as a percentage of GDP).

- **Monetary and price stability**. A stable monetary environment is the foundation for the efficient operation of a market economy. In contrast, monetary and price instability make both the price level and relative prices unpredictable, generates uncertainty, and undermines the security of contracts. Hence, high and volatile inflation undermines growth by reducing long-term investment and the productivity of capital. Barro (1995) suggests that for countries where inflation exceeds 15 percent, a 10 percent increase in inflation leads to a decline in GDP growth per year of 0.2-0.3 percent and a fall in the investment-to-GDP ratio of about 0.4-0.6 percent. In turn, high and volatile inflation is a consequence of excessive monetary growth. De Grauwe and Polan (2005) find in a sample of 160 countries over 30 years a very strong relationship between inflation and monetary growth, but the average strength is largely accounted for by their close association in high- (or hyper-) inflation countries. The relationship between inflation and money growth for low-inflation countries (averaging less than 10 percent) is weak.

- **Openness to international trade**. Trade liberalization enhances competition and efficiency in production and allows for technology transfer—all powerful forces for increased TFP. Openness to trade is proxied by the ratio of total exports plus imports to GDP. Frankel and Romer (1999) estimate that raising the ratio of trade to GDP by 1 percentage point would increase income per capita between 0.5 and 2.0 percent.

- **Financial sector development**. A strong financial sector leads to higher saving and efficiency and thus to higher economic growth. Financial institutions screen potential

[4] Government activity in areas that offer a comparative advantage (production of public goods) will enhance growth, but continued expansion as a share of GDP will eventually have a negative impact on the economy as expenditures are channeled into less-productive (and later counterproductive) activities. The rate of economic growth will then diminish and eventually decline.

entrepreneurs, mobilize savings, finance the most productive projects, and monitor management of these projects so that funds allocated are spent as envisaged. Financial deepening is proxied here by the ratio of bank deposits to GDP and the ratio of credit to the private sector to GDP. King and Levine (1993a, 1993b) find a positive relationship between financial development and subsequent rates of economic growth, physical capital accumulation, and productivity growth, even after controlling for other standard determinants of growth. Using more recent dynamic panel data techniques, Beck, Levine, and Loayza (2000) find that financial development improves economic growth mainly by accelerating TFP. Benhabib and Spiegel (2000) find that a standard deviation increase in the ratio of private sector credit-to-GDP would increase annual growth by 0.7 percent.

- **Institutions and political stability**.[5] A well-functioning, dynamic market economy requires institutions that secure property rights and political stability, promote the rule of law, enforce contracts, and limit the power of rulers. Without well-defined and secured property rights, accumulation of physical and human capital and investment in research and development cannot take place. Political instability saps economic growth by disrupting the business environment and economic activity, creating economic uncertainty and therefore decreasing incentives to invest. The quality of institutions and political stability are measured by two indices, *POLITY* and *DURABLE*, from a University of Maryland database.

- **Physical capital formation.** Physical investment has a direct effect on growth by increasing the economy's capital stock. Because it tends to embody transfers of technology, it also determines TFP growth (Romer, 1986; DeLong and Summers, 1991). The growth rate of physical capital per capita is used to proxy investment.

- **Human capital accumulation.** A well-educated and healthy workforce directly and indirectly increases economic growth. The more human knowledge there is, the more innovation, and the stronger TFP and economic growth are. In the case of developing countries, human capital facilitates effective adoption of new technologies from abroad (Benhabib and Spiegel, 1994). The average number of years of schooling of the labor force (from the Barro-Lee database) is used as a proxy for human capital accumulation.

- **Foreign aid.** Foreign aid may induce growth if it finances investment rather than consumption. Furthermore, aid-financed investment may raise TFP by limiting the strains on the domestic tax base, preventing costly distortions, in financing infrastructure projects (roads and irrigation projects) and investment in human capital (education or basic health care), for which the private rate of return is generally lower than the social one. We use the ratio of official development assistance (ODA)-to-GDP. Burnside and Dollar (2000) argue that aid raises economic growth if it is provided to

[5] North (1990) defines institutions as the "formal and informal constraints on political, economic, and social interactions."

countries with good policies.[6] Empirical studies that find a positive relationship suggest that for every 1 percent of GDP received in aid, countries with good policies grow by 0.5 percent more.

- **Terms-of-trade and other exogenous shocks.** Terms-of-trade shocks are a key source of business cycles and hence TFP growth in developing countries, especially when foreign trade is less diversified. Mendoza (1995) shows that terms-of-trade shocks account for nearly half of actual GDP variability in developing countries. In the case of Niger, drought is another major exogenous shock that affects GDP. History shows that a serious drought reduces growth by several percentage points annually. Droughts tend to occur in Niger every four or five years. A dummy variable taking the value of 1 in periods of drought and 0 elsewhere is used in the analysis.

The following modified neoclassical growth model is estimated to investigate the role of macroeconomic and other variables in determining economic growth:

$$gy_t = a_0 + a_1 gk_t + a_2\, govcons_t + a_3\, finance_t + a_4\, aid_t + a_5\, tot_t + a_6\, drought_t + a_7\, open_t +$$

$$a_8\, inf_t + a_9\, ghucap_t + a_{10}\, fiscbal_t + a_{11}\, polity_t + a_{12}\, durable_t + \varepsilon_t \qquad (6)$$

where *gy* is the rate of change of real income per capita, *gk* is the rate of change of physical capital per capita, *govcons* is a measure of government size, *finance* is a measure of financial development (proxied by bank deposits as a percent of GDP), *aid* is official development assistance (percent of GDP), *tot* is the growth rate of the terms of trade, *drought* is the drought dummy variable, *open* is openness to trade, *inf* is the rate of inflation, *ghucap* is human capital growth, *fiscbal* is the overall fiscal balance (in percent of GDP), *polity* is a measure of institutional quality, *durable* is a measure of political stability, a_0 is the constant term, and ε is the error term.

We hypothesize that these variables are primarily determinants of TFP growth rather than physical capital accumulation. If they influence growth primarily through their impact on physical capital accumulation, we should not expect them to appear significant in equation (6), which already incorporates the rate of physical capital accumulation as an explanatory variable (Benhabib and Spiegel, 2000). Furthermore, we should expect the coefficient a_1 to be numerically very close to α in equation (2).

Equation (6) is estimated through ordinary least squares (OLS) with variables that are stationary and a lag number consistent with the lag length selected for the cointegration analysis. The general-to-specific methodology (removing the variables with t-values less than

[6] There is no agreement on this issue, however. For instance, Rajan and Subramanian (2005) argue that regardless of the situation—for example, in countries that have adopted sound economic policies or improved government institutions—or the type of assistance, aid does not appear to stimulate growth over the short or the long term.

1.5) is used. Likelihood ratio tests are used to validate the selection procedure at each stage; the parsimonious model is evaluated using the standard diagnostic tests.

Figure 3. Selected Economic and Institutional Variables

IV. EMPIRICAL RESULTS

Unit-Root Tests

We investigate the time-series properties of all the variables using the augmented-Dickey-Fuller (ADF) test. To estimate the production function, both capital and output (per worker) series were found to be unequivocally nonstationary. Once expressed in first differences, the output per worker series is stationary and integrated of the order 1 (or I(1)). In contrast, the first difference of the capital per worker series appears nonstationary, i.e., we cannot reject the hypothesis that the capital per worker series is I(2). Given the well-known low power of the ADF test, both series are assumed I(1). This conjecture is confirmed through cointegration analysis. To estimate equation (6), we use only stationary variables. Hence, to render them stationary the determinants of the growth rate of real income per capita are converted from level into growth rates or first difference of growth rates.[7]

Production Function

We apply the Johansen's procedure to a second-order vector autoregression (VAR(2)) version of equation (2) to test for cointegration between output and physical capital; see Table 1. Both the maximal and trace eigenvalue statistics reject the null hypothesis of no cointegrating vector in favor of one cointegration vector[8]:

$$y = 2.9 - 0.007\, t + 0.36\, k \qquad (7)$$

The estimated elasticity of output with respect to capital is significant and of the expected positive sign (see Table 1). The coefficient of the trend is negative, suggesting that TFP growth was on average negative over the sample period. The estimated parameter of the production function is close to the value of 0.35 found by Sacerdoti and others (1998) for West African countries, including Niger. Senhadji (2000) finds an average value of 0.43 for sub-Saharan Africa, while Bosworth and others (1995) find a coefficient of 0.4 for developing countries. Table 2 reports the misspecification tests of the unrestricted VAR(2). The assumption of normality for the physical capital series and the system as a whole is violated. As demonstrated by Gonzalo (1994), however, the Johansen procedure is robust under non-normal errors. The validity of the system can therefore be taken with confidence.

The test for weak exogeneity of capital was not rejected, but it was rejected for the output series, suggesting that output (rather than capital) adjusts to any temporary disequilibrium in the cointegrating relationship. These results imply that it is valid to condition output growth on the growth rate of physical capital and proceed with a single-equation model. Figure 4 displays the recursive estimates of the parameters of the cointegrating vector under the assumption of

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[7] Results of these tests can be obtained from the authors.

[8] The appropriate lag length for the VAR and cointegration analysis was determined using Wald F-tests and the Bayesian Schwarz Criterion (BSC).

weak exogeneity of capital and these are relatively stable throughout the 1990s and early 2000s. The estimated speed of adjustment is negative at about 80 percent, suggesting a fairly rapid adjustment to any temporary disequilibrium. In the absence of other shocks, the time required to reduce any disequilibrium by 50 percent is 0.43 years (5.2 months).[9]

Table 1. Cointegration Analysis of Production Function

Eigenvalues	0.48	0.18	...
Hypotheses	$r = 0$	$r <= 1$	...
Lambda trace	30.12*	6.91	...
Lambda max	23.22*	6.91	...
Unrestricted vector		Standardized eigenvectors	
	y	*k*	*trend*
	1.000	-0.359	0.007
		Standardized adjustment coefficients	
	y	*k*	...
	-0.80	0.02	...
Restricted vector		Standardized eigenvectors	
	y	*k*	*trend*
	1.000	-0.347	0.007
		Standardized adjustment coefficients	
	y	*k*	...
	-0.80	0.00	...
		Weak exogeneity test statistics: $\chi^2(1)$	
	y	*k*	...
	16.92**	0.08	...
		Statistics for testing the significance of a given variable: $\chi^2(1)$	
	y	*k*	*trend*
	17.40**	7.61**	16.27**
		Multivariate statistics for testing stationarity: $\chi^2(2)$	
	y	*k*	...
	16.56**	17.45**	...

Notes:
1. The estimation period is 1965-2003. See Appendix for definitions and sources of variables. The VAR includes two lags on each variable, a constant and a trend term. Johansen's maximal and trace eigenvalue statistics for testing cointegration are adjusted for degrees of freedom.
2. The systems-based test statistics for weak exogeneity, significance, and stationarity are evaluated on the assumption that $r=1$ and hence are assymptotically distributed as $\chi^2(1)$, $\chi^2(1)$, or $\chi^2(2)$ if weak exogeneity, no long-run presence, or stationarity of the specified variable is accepted.

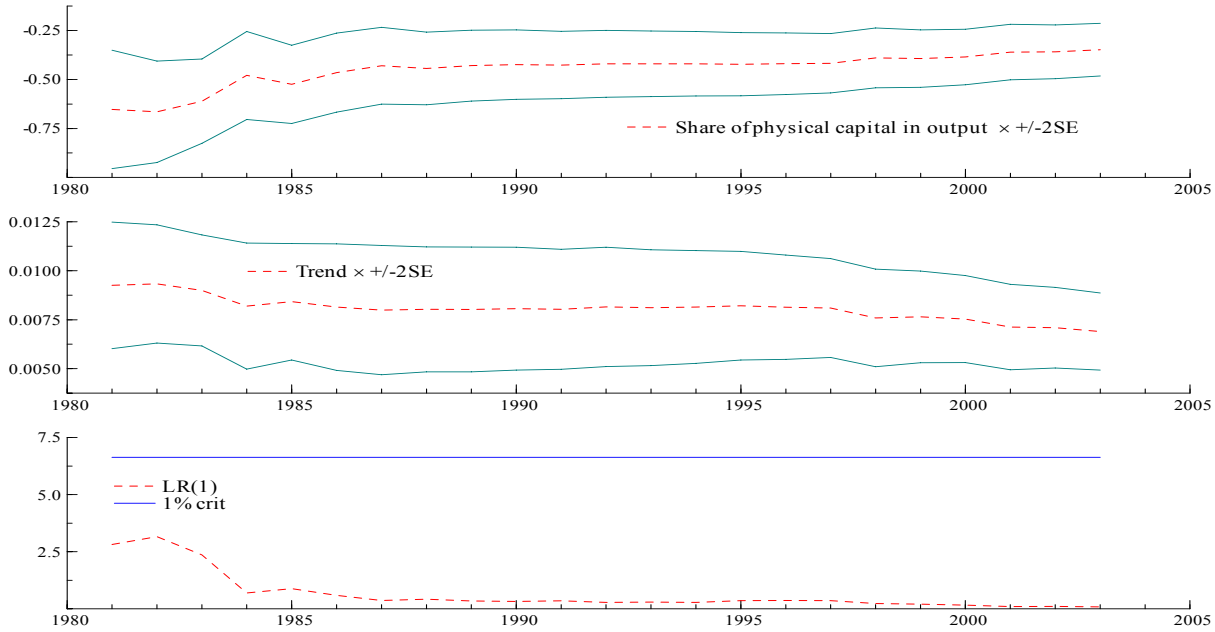
[9] This is computed through $(1 - \gamma)^t = (1 - \delta)$, where γ is the estimated speed of adjustment and δ is the share of the targeted catch up (e.g., 0.5 for a half-life reduction).

Table 2. Properties of VAR(2) Residuals

	y	*k*	*Vector*
Portmanteau (5)	3.81	6.05	26.83
AR 1-2	0.28	0.22	0.62
Normality	2.61	9.66**	13.8**
ARCH 1-1	0.33	1.90	…
Hetero	1.18	1.67	0.99
Hetero-X	0.65	3.45*	1.27

Notes:
1. See Appendix for definitions and sources of the variables.
2. AR denotes the results of LM (Lagrange multiplier) tests for residual autocorrelation of each single equation and of the system. Normality denotes the results of the Doornik-Hansen test for each variable and for the system as a whole. It checks whether the residuals are normally distributed. ARCH denotes the results of the LM tests for autocorrelated squared residuals. The portmanteau statistic is a degrees-of-freedom corrected version of the Box and Pierce statistic for each variable and for the system as a whole. See Doornik and Hendry (2001) for details.
3. * and ** denote rejection at the 5 percent and 1 percent critical values, respectively.

Figure 4. Recursive Estimates of Production Function, 1981-2003



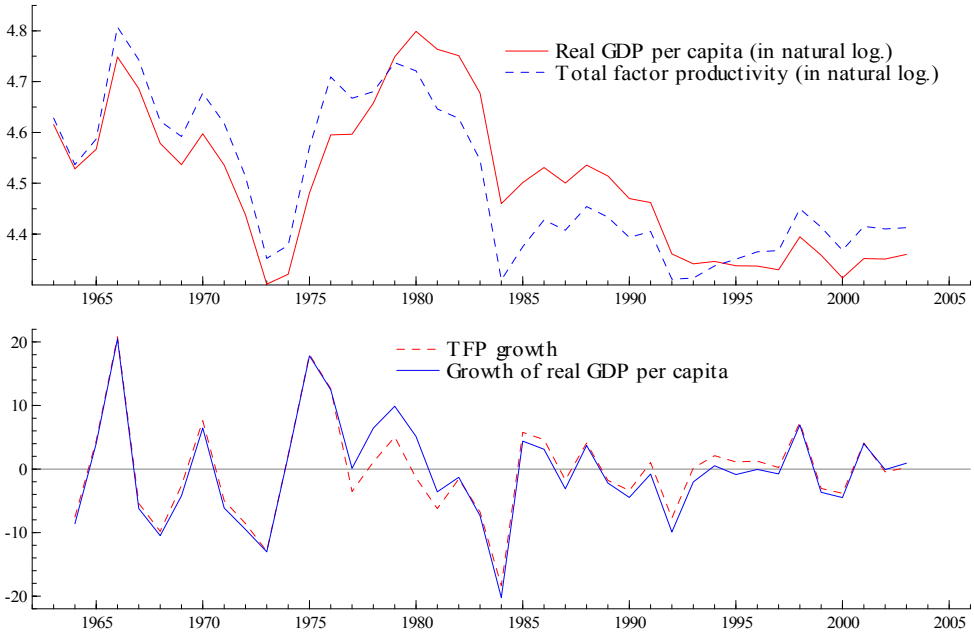
Johansen uses a systems approach of testing the existence of unit roots in each variable when the null hypothesis is stationarity, rather than nonstationarity. The chi-square statistics reported in Table 1 suggest that both series are nonstationary and integrated of the order 1, confirming our conjecture with respect to capital per worker.

Table 3. Growth Accounting, 1964-2003

	Growth Rate of Output per Worker	Contribution of	
		Physical Capital per Worker	Total Factor Productivity
1964-1978	0.75	-0.01	0.76
1979-1982	2.49	3.01	-0.52
1983-1993	-3.42	-0.94	-2.48
1994-2003	0.23	-0.57	0.80
1964-2003	-0.35	-0.10	-0.25

Notes:
1. The share of physical capital in income is 0.35.
2. The growth rate of total employment is proxied by the rate of population growth. The annual growth rate of population is 2.7 percent for 1964-82 and 3.3 for 1983-2003.

Figure 5. Output per Capita and Total Factor Productivity



Growth Accounting

We analyze Niger's sources of growth for four periods between 1964 and 2003: 1964-78, 1979-82, 1983-93, and 1994-2003. Table 3 shows that the highest economic growth in Niger coincided with the most rapid capital accumulation (1979-82), though TFP growth was negative. The higher growth rate of capital per worker was linked to increased production and investment in the uranium sector. Output declined steadily between 1983 and 1993 largely because of a significant drop in TFP. Economic growth resumed after devaluation (1994-2003) as efficiency in the use of factors of production improved, as shown by positive TFP growth. Productivity was stimulated by the improved external competitiveness of the economy and major structural reforms. But over the entire 1964-2003 survey period, income per capita declined by 0.3 percent per year owing to negative growth rates of both TFP (accounting for 70.6 percent of the decline) and physical capital per capita (29.4 percent).

The Determinants of Per Capita Output and TFP Growth

Investigation of the role of policy variables and other determinants of growth produced interesting results that are broadly consistent with the predictions of our model (see Table 4; specification 1 is the preferred one):

- **Physical capital formation** has a positive and significant effect on economic growth with a coefficient (0.40) that is numerically close to, and statistically not significantly different from, the estimated capital share of 0.35-0.36. To add 1 percent of growth in output in Niger, capital stock would have to grow 2.5-2.8 percent annually.

- **Government consumption** has a negative but only marginally significant effect. This finding suggests that a significant share of current expenditure in Niger over the sample period was channeled into counterproductive activities. Despite the government's efforts, recurrent expenditures still accounted for 60 percent of total spending during 2000-03 (see World Bank, 2005). Wages and salaries, interest payments on external debt, and subsidies and transfers accounted for 34 percent, 13 percent, and 20 percent of recurrent expenditure, respectively, over the same period.[10] That is why improving the management of public expenditure should have high priority.

- **Foreign aid** has positive and highly significant growth effects: a 1 percentage point increase in the ODA-to-GDP ratio induces slightly more than an 0.7 percentage point increase in per capita income growth. In the past, Niger's growth has slowed when donor financing was either cut off or delayed. While Niger continues to rely on foreign aid to finance development, this aid should be directed to investments in infrastructure and rural development (especially irrigation) projects. Figure 3 shows that ODA tends to be volatile. After declining in the 1990s because of political instability, ODA has recovered since 2000 but is still far lower than its levels in the 1980s and 1990s.

- **Openness to trade** has a positive and significant impact on growth. The cumulative impact over two years of a percentage point increase in openness is 0.6 percent, which is consistent with Frankel and Romer (1999). In 1996, Niger's trade openness rating fell to 2 on the IMF's 10-point scale and by 2002 it had declined to 1. The lower the ranking on the 10-point scale, the greater the trade openness. A value of 1 means that the economy is fully open to external trade. This opening led to a significant increase in trade with other members of the West African Economic and Monetary Union and had a positive impact on Niger's growth prospects as exports increased. Figure 3 shows that after declining steadily since the late 1980s, openness to trade increased in 1994 and thereafter stabilized. Despite the very open trade regime, there has been little trade diversification: Niger's main export products, uranium and cattle, still accounted for about 50 percent of total exports over 2002-03.

[10] Interest payments on external debt have declined since 2001, thanks to HIPC debt relief. Subsidies and transfers have been rising since 1999 because of subsidies on some agricultural imports and increasing welfare obligations (see World Bank, 2005).

- **Financial development** has a strong positive and significant effect on economic growth; a 1 percentage point increase in the *change* in the ratio of bank deposits to GDP induces a more than 1.5 percentage point increase in per capita income growth. This suggests that financial development should be a key element of Niger's development and poverty reduction strategy. Restructuring banks and monitoring them more closely could increase confidence in the financial system.

- **Terms-of-trade shocks** have a positive but marginally significant effect on growth. Improvements in the terms of trade make Niger produce more and expand exports. The impact was most pronounced in the 1979-82 period, the heyday of uranium exports.

- **Drought** has a highly significant and costly effect: periods of drought have cost an annual average of 10 percentage points of real per capita income growth. Given Niger's heavy dependence on agriculture and its susceptibility to droughts and other vagaries of the weather, building up infrastructure to mitigate these risks is crucial. Investments in irrigation systems, storage facilities, and rural roads should be a priority.

- **The quality of institutions** has an unexpected negative sign but it is only marginally significant. However, more democracy is not always positively correlated with higher economic growth (see, for instance, Barro, 1996). Moreover, capturing this impact in a time series context (rather than a panel or cross section) is difficult.

- The **stability of institutions** has the expected positive sign but it is not significant. Historically, however, sustained growth has occurred during the most stable periods. We attribute this result to the difficulty of capturing this impact using a time series.

- **Human capital accumulation** has the expected sign but again it is not significant. We attribute this result to the poor proxy used for human capital and, again, the difficulty of capturing this impact with a time series. The lack of significant positive association between growth in schooling and economic growth has been noted in several empirical studies.[11] Primary enrollment rates in Niger increased from 32.2 percent in 1998-99 to 45.5 percent in 2002-03.

- The fact that **inflation** is not significant suggests that monetary policy, which is conducted regionally by the Central Bank of West African States, has been credible in lowering investor and consumer inflation expectations. Figure 3 shows that inflation was much higher and volatile in the 1960s and 1970s than later in the sample period.

- The **fiscal balance**-to-GDP ratio has the expected positive sign but it is not significant, suggesting that the stance of fiscal policy did not undermine Niger's growth.

[11] Pritchett (2001) finds no positive correlation between growth in education and growth in output per worker. Benhabib and Spiegel (1994) find no relationship between years of schooling and economic growth, even after controlling for other determinants of growth.

Table 4. Determinants of the Growth Rate of Real GDP Per Capita, 1967-2003

The dependent variable is the growth rate of real GDP per capita (*gy*).	Specifications					
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-9.56 (-5.16)**	-9.86 (-5.17)**	-9.30 (-4.90)**	-9.67 (-5.16)**	-9.50 (-5.31)**	-9.55 (-5.20)**
gk	0.40 (2.99)**	0.43 (3.06)**	0.44 (3.05)**	0.40 (2.97)**	0.39 (3.03)**	0.39 (2.88)**
tot	0.10 (2.05)*	0.08 (1.93)*	0.08 (1.82)*	0.09 (2.03)*	0.08 (2.02)*	0.07 (1.63)
Δ*govcons* (t) + Δ*govcons* (t-1)	-0.60 (-1.91)*	-0.58 (-1.83)*	-0.60 (-1.87)*	-0.56 (-1.71)	-0.48 (-1.54)	-0.56 (-1.78)*
Δ*open* (t) + Δ*open* (t-1)	0.28 (3.25)**	0.28 (3.16)**	0.30 (3.31)**	0.30 (3.29)**	0.29 (3.41)**	0.28 (3.26)**
aid (t-1)	0.74 (5.47)**	0.76 (5.44)**	0.72 (5.25)**	0.74 (5.46)**	0.74 (5.72)**	0.74 (5.53)**
finance (t-1)	1.58 (3.37)**	1.55 (3.27)**	1.64 (3.43)**	1.56 (3.29)**	1.6 (3.55)**	1.43 (2.99)**
drought	-9.98 (-5.29)**	-10.54 (-5.16)**	-10.12 (-5.30)**	-10.00 (-5.26)**	-10.22 (-5.60)**	-10.12 (-5.40)**
Δ*ghucap* (t-1)	.. ..	0.30 (0.76)	.. ..	.. ..	.. ..	.. ..
Δ*fiscbal* (t-1)	.. ..	.. ..	0.25 (0.76)	.. ..	.. ..	.. ..
Δ*inf*	.. ..	.. ..	.. ..	-0.04 (-0.71)	..	.. ..
Δ*polity* (t) + Δ*polity* (t-1)	.. ..	.. ..	.. ..	.. ..	-0.20 (-1.78)	.. ..
Δ*durable* (t-1)	.. ..	.. ..	.. ..	.. ..	.. ..	0.15 (1.21)
Sigma	3.44	3.46	3.46	3.47	3.31	3.40
R^2	0.81	0.81	0.81	0.81	0.83	0.82
Number of observations	37	37	37	37	37	37
F(7, 29) or F(8, 28)	17.43**	15.10**	15.09**	15.06**	16.78**	15.67**
DW	1.73	1.67	1.73	1.78	1.91	1.83
Number of parameters	8	9	9	9	9	9

Notes:
1. See Appendix for definitions and sources of variables.
2. *t* statistics are in parentheses.
3. Δ denotes the absolute change of a given variable.
4. Specification 1 is the preferred one.

Table 5. Determinants of the Growth Rate of TFP, 1967-2003

The dependent variable is the growth rate of TFP ($\Delta A/A$).	Specifications					
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-9.31 (-5.47)**	9.45 (-5.45)**	-8.98 (-4.98)**	-9.41 (-5.46)**	-9.28 (-5.66**)	-9.37 (-5.56)**
tot	0.09 (2.18)*	0.09 (2.10)*	0.09 (2.03)*	0.09 (2.15)*	0.08 (2.14)*	0.07 (1.71)
Δ*govcons* (t) + Δ*govcons* (t-1)	-0.63 (-2.04)*	-0.62 (-2.00)*	-0.63 (-2.04)*	-0.58 (-1.84)*	-0.50 (-1.65)	-0.58 (-1.88)*
Δ*open* (t) + Δ*open* (t-1)	0.30 (3.41)**	0.29 (3.35)**	0.30 (3.24)**	0.31 (3.44)**	0.29 (3.57)**	0.29 (3.40)**
aid (t-1)	0.72 (5.87)**	0.73 (5.83)**	0.69 (5.40)**	0.72 (5.86)**	0.73 (6.16)**	0.72 (5.99)**
finance (t-1)	1.58 (3.42)**	1.55 (3.32)**	1.62 (3.44)**	1.56 (3.34)**	1.60 (3.60)**	1.43 (3.03)**
drought	-10.01 (-5.51)**	-10.61 (-5.27)**	-10.26 (-5.48)**	-10.12 (-5.48)**	-10.33 (-5.83)**	-10.21 (-5.62)**
Δ*ghucap* (t-1)	.. ..	0.25 (0.64)	.. ..	.. ..	.. ..	.. ..
Δ*fiscbal* (t-1)	.. ..	.. ..	0.19 (0.61)	.. ..	.. ..	.. ..
Δ*inf*	.. ..	.. ..	.. ..	-0.04 (-0.72)	.. 	.. ..
Δ*polity* (t) + Δ*polity* (t-1)	.. ..	.. ..	.. ..	.. ..	-0.20 (-1.82)	.. ..
Δ*durable* (t-1)	.. ..	.. ..	.. ..	.. ..	.. ..	0.15 (1.26)
Sigma	3.39	3.42	3.42	3.42	3.26	3.36
R^2	0.79	0.79	0.79	0.79	0.81	0.80
Number of observations	37	37	37	37	37	37
F(6, 30) or F(7, 29)	18.70**	15.78**	15.75**	15.85**	17.74**	16.57**
DW	1.70	1.63	1.67	1.74	1.88	1.81
Number of parameters	7	8	8	8	8	8

Notes:
1. See Appendix for definitions and sources of variables.
2. *t* statistics are in parentheses.
3. Δ denotes the absolute change of a given variable.
4. Specification 1 is the preferred one.

Excluding the growth rate of capital, all the explanatory variables in Table 4 are determinants of TFP growth, as can be seen in Table 5, which shows the results of regressing TFP growth on the variables. The estimated coefficients are numerically close to the ones in Table 4.

Table 6 shows the results of diagnostic tests of the various specifications reported in Tables 4 and 5. Our model performs well on statistical grounds. The diagnostic statistics test several alternative hypotheses—residual autocorrelation (AR), skewness and excess kurtosis (normality), autoregressive conditional heteroscedasticity (ARCH), unconditional heteroscedasticity (Hetero), and incorrect functional form (RESET). The estimated residuals are free of heteroscedasticity and autocorrelation but the hypothesis of normality is rejected for specifications 1-4. However, once we control for the quality of institutions or political instability (specifications 5 and 6), we cannot reject the hypothesis that the residuals are distributed normally and are white noise.

Table 6. Diagnostic Tests

Panel A. Determinants of the Growth Rate of Real GDP Per Capita, 1967-2003

	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5	Specification 6
AR -2	1 0.36	0.67	0.35	0.26	0.27	0.38
Normality	6.11*	7.69*	6.07*	7.63*	5.81	4.06
ARCH 1-1	0.00	0.02	0.01	0.07	0.07	0.08
Hetero	0.24	0.22	0.20	0.22	0.23	0.22
RESET	0.30	0.16	0.39	0.59	0.21	0.23

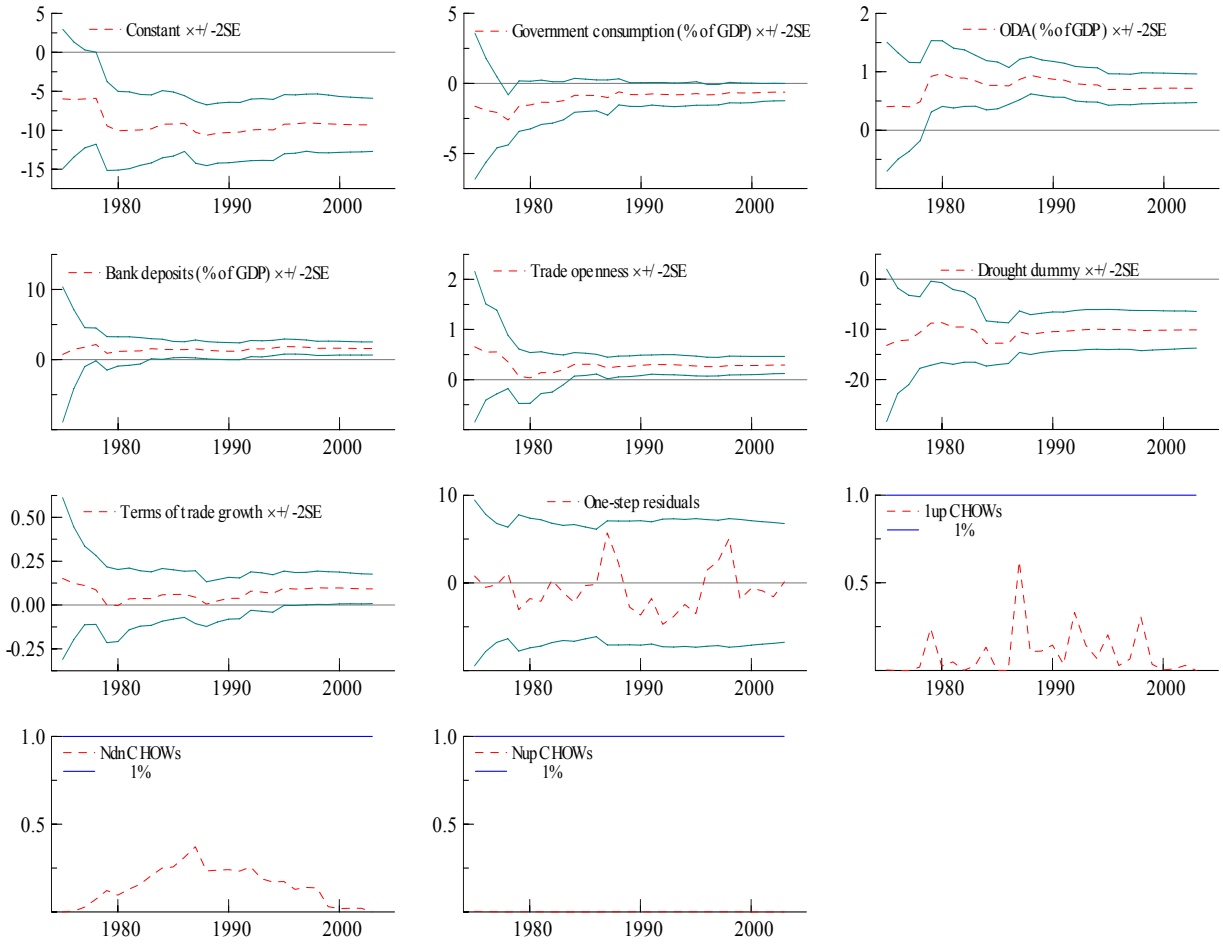
Panel B. Determinants of the Growth Rate of TFP, 1967-2003

	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5	Specification 6
AR -2	1 0.45	0.73	0.53	0.31	0.23	0.38
Normality	6.04*	7.16*	6.03*	7.36*	5.96	3.98
ARCH 1-1	0.00	0.01	0.01	0.07	0.01	0.08
Hetero	0.35	0.33	0.29	0.29	0.32	0.31
RESET	0.15	0.09	0.16	0.26	0.12	0.18

Notes:
1. * and ** denote rejection at the 5 percent and 1 percent critical values, respectively.
2. The Ramsey's RESET (regression specification error test) test adds the squared fitted values of the dependent variable to the linear regression and tests for the significance of this additional variable (Ramsey, 1969). It can therefore be interpreted as a test of incorrect functional form or a test of omitted variables which are proxied by powers of the mean function as estimated by the fitted values of the dependent variable.

Model stability and parameter constancy are also good over the sample period. Figure 6 shows that recursive estimates for all the variables are stable and increase in efficiency over the sample period. The recursive residuals of the parsimonious specification and the three Chow tests indicate similar stability. Thus the steady recursive estimation performance of the model lends support to the initial implicit assumption that over the sample period all the current dated variables of the model are weakly exogenous for the parameters of real GDP per capita growth.

Figure 6. Determinants of TFP Growth: Recursive Estimates and Stability Tests



V. CONCLUSIONS

Niger is essentially a rural and agrarian economy, with the primary sector (agriculture, livestock, forestry and fishery) employing more than 80 percent of the economically active population and generating more than 40 percent of GDP. Economic growth has consistently faltered, falling far short of what is needed to substantially improve living standards. Niger is highly vulnerable to exogenous shocks, especially periodic droughts and progressive desertification. Hence, growth performance is very volatile, with year-to-year changes in growth rates caused largely by the effect of weather conditions on agricultural output and livestock. It is therefore crucial for Niger to diversify its economy away from agricultural production and find new sources of growth. But that remains a formidable challenge, given the

country's scarcity of physical and human capital. Poverty is widespread, with almost two-thirds (63 percent) of the population living below the poverty line and about a third (34 percent) considered extremely poor.

This paper investigates the sources of economic growth and total factor productivity by first estimating a Cobb-Douglass production function over 1963-2003. The estimated share of capital in income (0.35), which is consistent with findings in the empirical literature, is then used to conduct a growth accounting analysis. Niger's per capita income declined an average of 0.3 percent a year for the study period; this disappointing economic performance is accounted for by negative growth rates of TFP (70.6 percent) and physical capital per capita (29.4 percent).

Contributing to the disappointing TFP growth were inappropriate macroeconomic policies, recurrent droughts, deterioration in the terms of trade, and political disturbances. Openness to trade, aid flows, terms of trade improvements, and financial sector development are all associated with higher TFP growth. Government consumption, political instability, and drought are negatively related to productivity growth.

Aid flows, the drought dummy, financial sector development, openness to trade, and physical capital accumulation are strongly correlated with growth in real income per capita. Government consumption and terms-of-trade shocks are marginally significant. Human capital, inflation, political stability, and the fiscal balance have the expected signs but are not significant. The quality of institutions has an unexpected negative sign but it, too, is not significant. We attribute the results for human capital, political stability, and the quality of institutions to the use of poor proxies and the difficulty of capturing their impact with a time series analysis.

We estimate that about 10 percent of real income per capita is lost annually during droughts. This points to the need to accelerate irrigation projects and nonfarm rural income-generating activities. With aid flows highly significant, targeted investments in irrigation systems and other infrastructure within agriculture can help accelerate the positive real income per capita growth observed since devaluation. This is especially important because a huge majority of the population relies on agriculture and livestock for their livelihood. Recurrent droughts make it impossible to sustain a level of growth that could bring significant improvements in living standards and begin to reduce poverty. With one of the world's highest population growth rates (3.3 percent), Niger will have to slow population growth to reduce poverty significantly.

APPENDIX. DEFINITIONS AND SOURCES OF VARIABLES

The data series are from the IMF *World Economic Outlook* (WEO) and *International Financial Statistics* (IFS) databases and the World Bank *World Development Indicators* (WDI) database.

gy: the rate of growth of real income per capita (percent). Source: WEO.

gk: the rate of growth of physical capital per capita (percent). Source: WEO.

govcons: government consumption (percent of GDP). Source: WEO.

finance: bank deposits (percent of GDP). Source: IFS.

open: imports plus exports (percent of GDP). Source: WEO.

drought: dummy variable taking the value 1 in periods of drought and 0 otherwise.

tot: rate of change of terms of trade (percent). Source: WEO.

aid: official development assistance (ODA) (percent of GDP). Source: WDI.

ghucap: rate of change of the average number of years of schooling of the labor force. Source: Barro and Lee (1996) database.

inf: rate of change of the consumer price index (percent). Source: IFS.

fiscbal: overall fiscal balance (percent of GDP). Source: WEO.

polity: indicator of the quality of institutions, ranging between -10 and +10 (-10 = high autocracy; +10 = high democracy). Source: University of Maryland, Center for International Development and Conflict Management.

durable: indicator of polity durability based on number of years since the last (3-point or greater) regime transition. Since this variable is coded from the year of the first regime transition or the first year of independence, it can be interpreted as a measure of political stability. Source: University of Maryland, Center for International Development and Conflict Management.

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