Paper – Modeling South African GDP Post-Apartheid

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for

Dr. Clarke - Spring 2019 EPPS 7371

Introduction

According to the African origin hypothesis modern humans likely originated in or around South Africa (SA) some 70,000 years ago. Thus, SA can, at least partially, be credited with the genesis of man. SA was largely left to its own development until the mid-1600 with the arrival of Dutch (called Afrikaners) settlers and traders. Britain took control of Cape Town, an important trading post, from the Dutch in 1795. Diamond and gold discovery in the late 1800 brought additional external immigration. The British and Afrikaners, ruled together from 1910 under the Union of SA. In 1961 the governing National Party instituted a policy of apartheid. This policy was designed to develop the white and black races separately. It favored the white minority over the black majority. The African National Congress (ANC) resisted apartheid and eventually leaders, like Nelson Mandela, convinced the white minority to transition to majority rule. Majority elections in 1994 ended apartheid policies (Lowenberg, 1997).

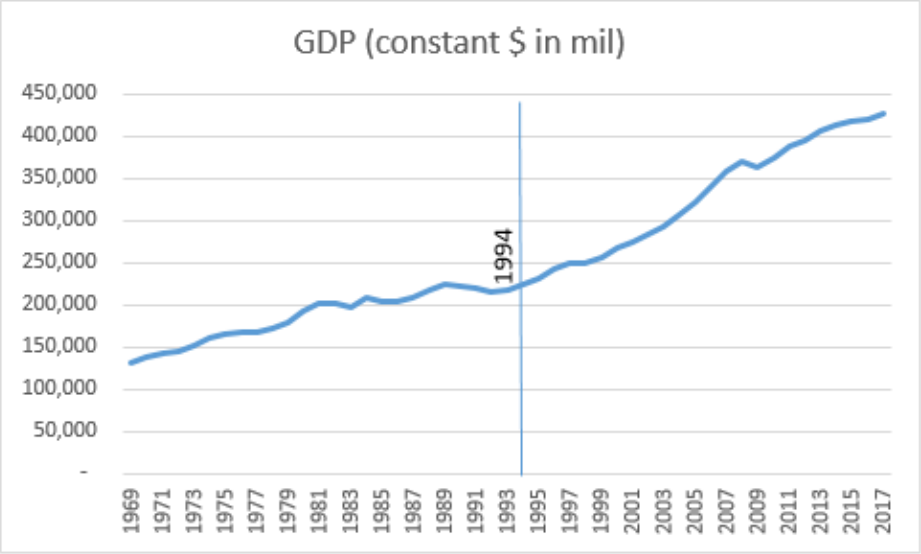
Most of the world cultures likely see the apartheid policy as lacking in intangible moral strength. However, the impacts on the nation's economic, education, and health care were its true tangible causalities. SA, at 1,219,000 sq. km, is the 25th largest country in the world (Mattyasovszky, 2015). SA is a middle-income emerging market with an abundant supply of natural resources; well-developed financial, legal, communications, energy, and transport sectors; and a stock exchange that is Africa's largest and among the top 20 in the world. Despite these advantages, SA unemployment, poverty, and inequality are among the highest in the world (The World Factbook, 2018).

The policies of apartheid created numerous imbalances resulting in such economic effects as:

- Over investment in capital at the expense of unskilled black labor employment
- Underdevelopment of necessary infrastructure improvements in black rural areas
- Restrictions on the manufacturing sectors
- Restrictive import policies creating dependence on capital inflows
- Limits from foreign banks on credit extension
- Unsustainable governmental administration expensive
- International economic sanctions

These challenges lead to a vicious cycle in which political instability contributed to net capital outflows and shortages of foreign exchange, necessitating contractionary macroeconomic policies, which caused more political instability, etc. (Lowenberg, 1997).

As noted above, apartheid began in 1961 and ended in 1994. A visual inspection of GDP in constant dollars indicates a greater positive trend in GDP after 1994:



In addition, the below analysis demonstrated that the average change in GDP growth rates during apartheid was negative while after apartheid it become neutral and a two-tailed t-test allowed for the conclusion that the difference between those rates are not statistically zero at a .05 level. See table below:

Annual Change in GDP Growth Percentage pre- and post-Apartheid
t-Test: Paired Two Sample for Means (24 random selected 1961 to 1993 Compared to 1994 to 2017)

	1967-1993	*1994-2017*
Mean	-0.32	0.00
Variance	9.50	3.38
Observations	24.00	24.00
Hypothesized Mean Difference	0.00	
t Stat	-0.56	
P(T<=t) one-tail	0.29	
t Critical one-tail	1.71	
P(T<=t) two-tail	0.58	
t Critical two-tail	2.07	

In order to control for the factors that control for GDP growth this paper will build a regression model to evaluate the impact on the growth rate of SA's Gross Domestic Product (GDP) after apartheid to determine if any conclusions might be drawn from this policy abolishment.

Methodological Approach

General economic theory postulates that GDP is a function of technology, capital investment and labor. The aggregate production function must pass through zero, because no GDP can be produced without inputs. And, it should slope up, because more inputs generate more output (Hoover, 2011 pp. 413-414).

A useful representation of the aggregate production function was developed by Charles Cobb and Paul Douglas (Coma & Douglas, 1928). This model is represented as follows:

$$GDP_t = A*Capital^{\alpha}_t * Labor^{\beta}_t * \varepsilon_t \quad \text{eq. [1]}$$

Here:

A	=	Technology (constant)
GDP_t	=	Gross Domestic Product
$Capital^{\alpha}_t$	=	Capital Investment
$Labor^{\beta}_t$	=	Labor pool
ε_t	=	Error term

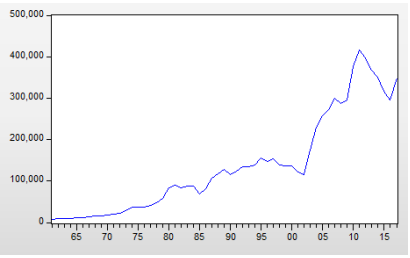
A is a positive constant that is understood as the state of the economy's technology. The exponent α and β are constant greater than zero and less than one ($0 < \alpha, \beta < 1$) (Hoover, 2011 p. 414).

Each value will be operationalized using data from the World Bank open data website (World Bank Open Data, n.d.) over the period 1970 to 2017 as follows (note, constant dollars were not available per 1970):

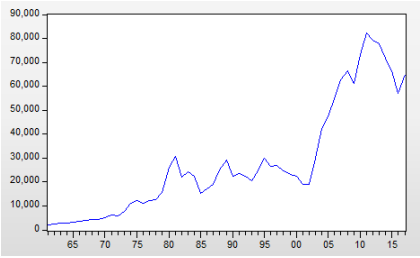
GDP_t	= SA GDP (constant US$)
$Capital^{\alpha}_t$	= SA Gross capital formation (constant US$)
$Labor^{\beta}_t$	= SA Labor force, total

Below are graphs and summary statistics for each dataset:

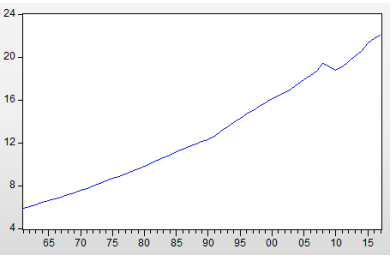
GDP (mil)



Capital Formation (mil)



Labor Force (mil)



	GDP	Capital Formation	Labor Force
Observations	57	57	57
Mean	137,269.2	28,127.6	12.9
Median	115,748.1	22,447.6	12.1
Maximum	416,418.9	82,121.8	22.0
Minimum	7,972.8	2,232.4	5.9
Std. Dev.	118,868.8	23,333.6	4.9

All Values in Millions (except observations)

From the graphs all variables appear to be trending. In order to confirm this visual evaluation autocorrelation and partial-autocorrelation and a Dickey-Fuller analyses were prepared. Below are the results:

GDP (mil)

Included observations: 57

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.945	0.945	53.593	0.000
		2	0.891	-0.011	102.16	0.000
		3	0.834	-0.064	145.45	0.000
		4	0.767	-0.120	182.79	0.000
		5	0.697	-0.068	214.24	0.000
		6	0.624	-0.070	239.94	0.000
		7	0.540	-0.148	259.53	0.000
		8	0.454	-0.072	273.66	0.000
		9	0.388	0.141	284.18	0.000
		10	0.331	0.081	292.02	0.000

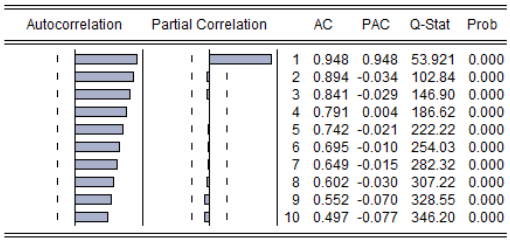
Null Hypothesis: GDPMIL has a unit root
Exogenous: Constant
Lag Length: 9 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.068507	0.9967
Test critical values:	1% level	-3.577723	
	5% level	-2.925169	
	10% level	-2.600658	

*MacKinnon (1996) one-sided p-values.

Capital Formation (mil)

Included observations: 57



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.948	0.948	53.921	0.000
		2	0.894	-0.034	102.84	0.000
		3	0.841	-0.029	146.90	0.000
		4	0.791	0.004	186.62	0.000
		5	0.742	-0.021	222.22	0.000
		6	0.695	-0.010	254.03	0.000
		7	0.649	-0.015	282.32	0.000
		8	0.602	-0.030	307.22	0.000
		9	0.552	-0.070	328.55	0.000
		10	0.497	-0.077	346.20	0.000

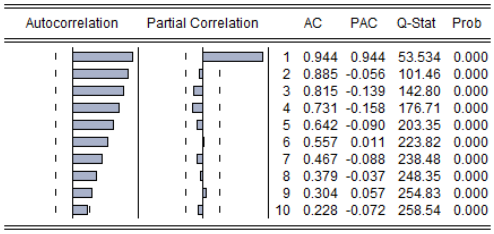
Null Hypothesis: LABORFORCEMIL has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		2.857333	1.0000
Test critical values:	1% level	-3.552666	
	5% level	-2.914517	
	10% level	-2.595033	

*MacKinnon (1996) one-sided p-values.

Labor Force (mil)

Included observations: 57



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.944	0.944	53.534	0.000
		2	0.885	-0.056	101.46	0.000
		3	0.815	-0.139	142.80	0.000
		4	0.731	-0.158	176.71	0.000
		5	0.642	-0.090	203.35	0.000
		6	0.557	0.011	223.82	0.000
		7	0.467	-0.088	238.48	0.000
		8	0.379	-0.037	248.35	0.000
		9	0.304	0.057	254.83	0.000
		10	0.228	-0.072	258.54	0.000

Null Hypothesis: CAPFORMUSDOLMIL has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

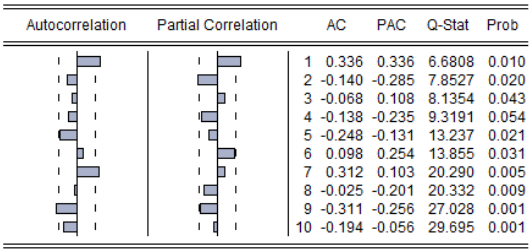
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.368429	0.9070
Test critical values:	1% level	-3.552666	
	5% level	-2.914517	
	10% level	-2.595033	

*MacKinnon (1996) one-sided p-values.

Given the slow declining autocorrelation, sharp declining partial correlation and the Dickey-Fuller tests indicating that the null hypothesis of unit root cannot be rejected, it was concluded that the level data do have a unit root and are therefore nonstationary. This trending will create potentially spurious regressions. In order to remove this trending the variables were first differenced and the same set of test performed. The results are bellow.

GDP (mil) – lagged one

Included observations: 56



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.336	0.336	6.6808	0.010
		2	-0.140	-0.285	7.8527	0.020
		3	-0.068	0.108	8.1354	0.043
		4	-0.138	-0.235	9.3191	0.054
		5	-0.248	-0.131	13.237	0.021
		6	0.098	0.254	13.855	0.031
		7	0.312	0.103	20.290	0.005
		8	-0.025	-0.201	20.332	0.009
		9	-0.311	-0.256	27.028	0.001
		10	-0.194	-0.056	29.695	0.001

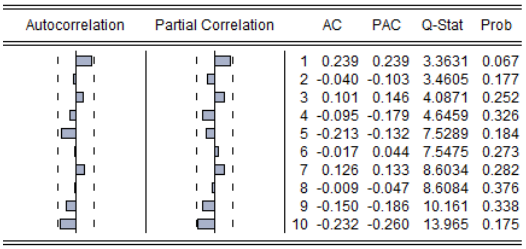
Null Hypothesis: D_GDPMIL has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.328449	0.0191
Test critical values:	1% level	-3.577723	
	5% level	-2.925169	
	10% level	-2.600658	

*MacKinnon (1996) one-sided p-values.

Capital Formation (mil) – lagged one

Included observations: 56



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.239	0.239	3.3631	0.067
		2	-0.040	-0.103	3.4605	0.177
		3	0.101	0.146	4.0871	0.252
		4	-0.095	-0.179	4.6459	0.326
		5	-0.213	-0.132	7.5289	0.184
		6	-0.017	0.044	7.5475	0.273
		7	0.126	0.133	8.6034	0.282
		8	-0.009	-0.047	8.6084	0.376
		9	-0.150	-0.186	10.161	0.338
		10	-0.232	-0.260	13.965	0.175

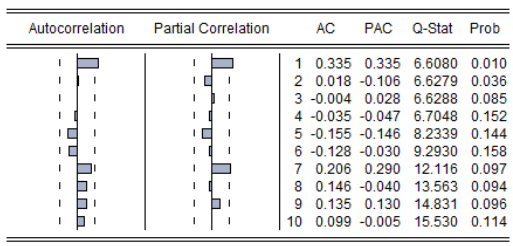
Null Hypothesis: D_CAPFORMUSDOLMIL has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.559155	0.0000
Test critical values:	1% level	-3.555023	
	5% level	-2.915522	
	10% level	-2.595565	

*MacKinnon (1996) one-sided p-values.

Labor Force (mil) – lagged one

Included observations: 56



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.335	0.335	6.6080	0.010
		2	0.018	-0.106	6.6279	0.036
		3	-0.004	0.028	6.6288	0.085
		4	-0.035	-0.047	6.7048	0.152
		5	-0.155	-0.146	8.2339	0.144
		6	-0.128	-0.030	9.2930	0.158
		7	0.206	0.290	12.116	0.097
		8	0.146	-0.040	13.563	0.094
		9	0.135	0.130	14.831	0.096
		10	0.099	-0.005	15.530	0.114

Null Hypothesis: D_LABORFORCEMIL has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.161653	0.0001
Test critical values:	1% level	-3.555023	
	5% level	-2.915522	
	10% level	-2.595565	

*MacKinnon (1996) one-sided p-values.

The first differenced variables show fluctuating autocorrelations and partial correlations and the Dickey-Fuller tests indicate that the null hypothesis of unit root can be rejected and, therefore, allow the conclusion that the first differenced level data do not have a unit root and are therefore stationary.

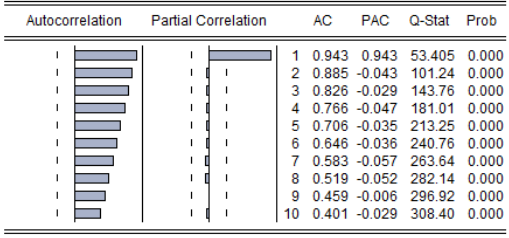
In order to effectively represent the Cobb-Douglas model's exponential nature each of the variables were logarithmic transformed effectively converting them into growth rates. Therefore, the new model becomes:

$$\text{Log}(GDP_t) = \text{Log}(A) + \alpha * \text{Log}(Capital_t) + \beta * \text{Log}(Labor_t) + \varepsilon_t \qquad \text{eq. [2]}$$

Although the transformed series should remain nonstationary similar to the level dataset the autocorrelation and partial-autocorrelation analyses, and a Dickey-Fuller analysis were prepared to confirm. Below are those test demonstrating that the transformed variables are nonstationary:

Log transformed GDP

Included observations: 57



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.943	0.943	53.405	0.000
		2	0.885	-0.043	101.24	0.000
		3	0.826	-0.029	143.76	0.000
		4	0.766	-0.047	181.01	0.000
		5	0.706	-0.035	213.25	0.000
		6	0.646	-0.036	240.76	0.000
		7	0.583	-0.057	263.64	0.000
		8	0.519	-0.052	282.14	0.000
		9	0.459	-0.006	296.92	0.000
		10	0.401	-0.029	308.40	0.000

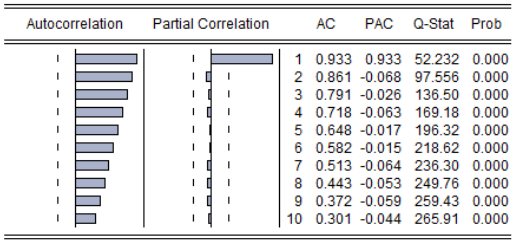
Null Hypothesis: L_GDP has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.987796	0.2912
Test critical values:	1% level	-3.557472	
	5% level	-2.916566	
	10% level	-2.596116	

*MacKinnon (1996) one-sided p-values.

Log transformed Capital Formation

Included observations: 57



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.933	0.933	52.232	0.000
		2	0.861	-0.068	97.556	0.000
		3	0.791	-0.026	136.50	0.000
		4	0.718	-0.063	169.18	0.000
		5	0.648	-0.017	196.32	0.000
		6	0.582	-0.015	218.62	0.000
		7	0.513	-0.064	236.30	0.000
		8	0.443	-0.053	249.76	0.000
		9	0.372	-0.059	259.43	0.000
		10	0.301	-0.044	265.91	0.000

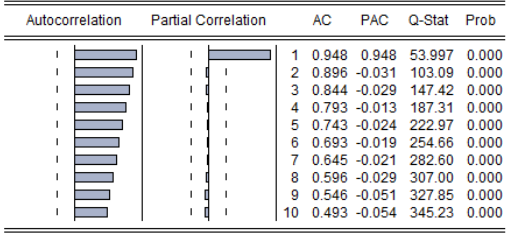
Null Hypothesis: L_CAPFORMUSDOL has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.808466	0.3728
Test critical values:	1% level	-3.552666	
	5% level	-2.914517	
	10% level	-2.595033	

*MacKinnon (1996) one-sided p-values.

Log transformed Labor Force

Included observations: 57



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.948	0.948	53.997	0.000
		2	0.896	-0.031	103.09	0.000
		3	0.844	-0.029	147.42	0.000
		4	0.793	-0.013	187.31	0.000
		5	0.743	-0.024	222.97	0.000
		6	0.693	-0.019	254.66	0.000
		7	0.645	-0.021	282.60	0.000
		8	0.596	-0.029	307.00	0.000
		9	0.546	-0.051	327.85	0.000
		10	0.493	-0.054	345.23	0.000

Null Hypothesis: L_LABORFORCE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.594090	0.1002
Test critical values:	1% level	-3.552666	
	5% level	-2.914517	
	10% level	-2.595033	

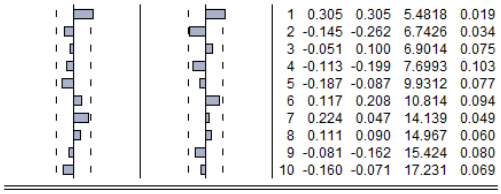
*MacKinnon (1996) one-sided p-values.

In each case the null hypothesis that the series has a unit root could not be rejected and therefore the series is nonstationary.

In order to maintain stationarity the log values were differenced. Again stationarity was evaluated using autocorrelation and partial-autocorrelation analyses, and a Dickey-Fuller analysis. Below are those test demonstrating that the differenced variables are now stationary:

Log transformed first differenced GDP

Included observations: 56



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.305	0.305	5.4818	0.019
		2	-0.145	-0.262	6.7426	0.034
		3	-0.051	0.100	6.9014	0.075
		4	-0.113	-0.199	7.6993	0.103
		5	-0.187	-0.087	9.9312	0.077
		6	0.117	0.208	10.814	0.094
		7	0.224	0.047	14.139	0.049
		8	0.111	0.090	14.967	0.060
		9	-0.081	-0.162	15.424	0.080
		10	-0.160	-0.071	17.231	0.069

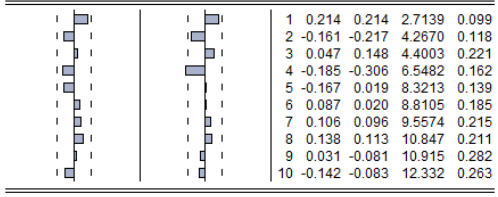
Null Hypothesis: DL_GDP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.260638	0.0000
Test critical values:	1% level	-3.555023	
	5% level	-2.915522	
	10% level	-2.595565	

*MacKinnon (1996) one-sided p-values.

Log transformed Capital Formation

Included observations: 56



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.214	0.214	2.7139	0.099
		2	-0.161	-0.217	4.2670	0.118
		3	0.047	0.148	4.4003	0.221
		4	-0.185	-0.306	6.5482	0.162
		5	-0.167	0.019	8.3213	0.139
		6	0.087	0.020	8.8105	0.185
		7	0.106	0.096	9.5574	0.215
		8	0.138	0.113	10.847	0.211
		9	0.031	-0.081	10.915	0.282
		10	-0.142	-0.083	12.332	0.263

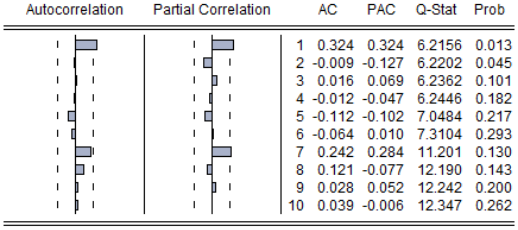
Null Hypothesis: DL_CAPFORMUSDOL has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.843790	0.0000
Test critical values:	1% level	-3.555023	
	5% level	-2.915522	
	10% level	-2.595565	

*MacKinnon (1996) one-sided p-values.

Log transformed Labor Force

Included observations: 56



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.324	0.324	6.2156	0.013
		2	-0.009	-0.127	6.2202	0.045
		3	0.016	0.069	6.2362	0.101
		4	-0.012	-0.047	6.2446	0.182
		5	-0.112	-0.102	7.0484	0.217
		6	-0.064	0.010	7.3104	0.293
		7	0.242	0.284	11.201	0.130
		8	0.121	-0.077	12.190	0.143
		9	0.028	0.052	12.242	0.200
		10	0.039	-0.006	12.347	0.262

Null Hypothesis: DL_LABORFORCE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.139344	0.0001
Test critical values:	1% level	-3.555023	
	5% level	-2.915522	
	10% level	-2.595565	

*MacKinnon (1996) one-sided p-values.

In all cases the autocorrelation and partial correlation analysis indicates stationarity, as well as, the null hypothesis of unit root from the Dickey-Fuller test can be rejected and it can be concluded the the series are stationary.

The new revised first difference logged model, therefore, becomes:

$$\text{Log}(GDP_t) - \text{Log}(GDP_{t-1}) = \alpha^*[\text{Log}(Capital_t) - \text{Log}(Capital_{t-1})]$$

$$+ \beta^*[(\text{Log}(Labor_t) - \text{Log}(Labor_{t-1})] + \varepsilon_t \qquad \text{eq. [3]}$$

The new specification represents an elasticity model*. Note that the Technology – the A term – which is assumed to be constant, drops from the equation when it is first differenced because differencing a constant results in a zero series. This transformed model was regressed using ordinary least squares (OLS) regression. Here are the results:

Variable	Coefficient	Standard Error
Capital	.21***	0.04
Labor	.66***	0.11
R-squared	0.38	
Durbin-Watson statistic	1.88	

***P<.01; **P<.05; *P<.10

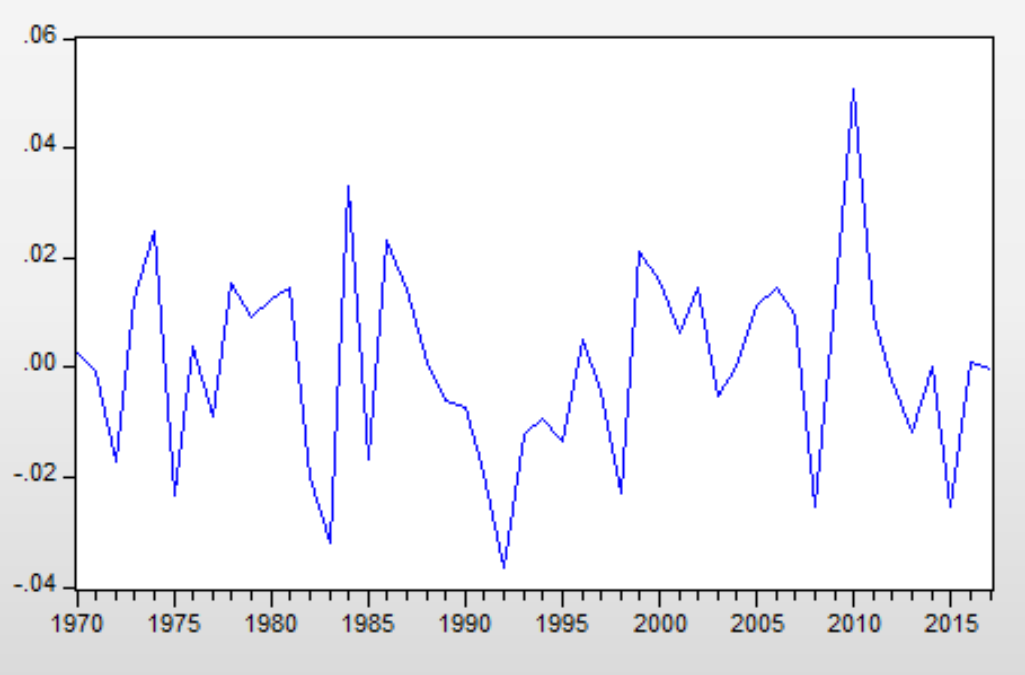
The α and β coefficients for Capital and Labor are significant to a .01 level and in a direction which is in accordance with theory. The R-squared value which indicates the percentage of variation explained by the regression is also relatively strong at 38%.

*Discrete growth rate = (GDPt – GDPt-1)/GDPt-1; Continuous growth rate = dt GDP(t) / GDP(t) and dt Log(GDP(t)) ≅ Log(GDPt) – Log(GDPt-1) ≅ (GDPt – GDPt-1)/GDPt-1 for small changes in GDP.

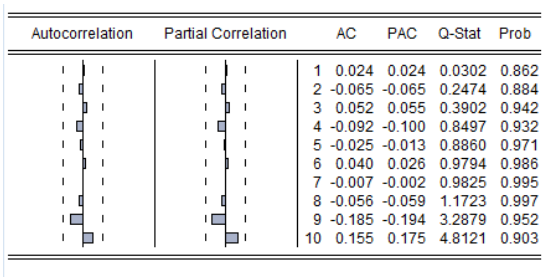
The Durbin Watson test measures autocorrelation in the regression residuals. A rule of thumb is that values ranging from 1.5 to 2.5 are normal. Values outside that range could be cause for concern (Durbin Watson Test & Test Statistic, 2017). Here the value of 1.88 is within the acceptable range indicating no autocorrelation in the residuals.

To test that the residuals are white noise as required by the ordinary least squares Gauss–Markov theorem assumptions (Hill, Griffiths, & Lim, 2011 p. 47), the following graphically representation of the residuals was prepared:

Regression Residuals



The residuals appear to be stationary. In order to confirm this visual evaluation autocorrelation and partial-autocorrelation analyses and a Dickey-Fuller test were prepared. Below are the results:



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.024	0.024	0.0302	0.862
		2	-0.065	-0.065	0.2474	0.884
		3	0.052	0.055	0.3902	0.942
		4	-0.092	-0.100	0.8497	0.932
		5	-0.025	-0.013	0.8860	0.971
		6	0.040	0.026	0.9794	0.986
		7	-0.007	-0.002	0.9825	0.995
		8	-0.056	-0.059	1.1723	0.997
		9	-0.185	-0.194	3.2879	0.952
		10	0.155	0.175	4.8121	0.903

Null Hypothesis: RESID07 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.547650	0.0000
Test critical values:	1% level	-3.577723	
	5% level	-2.925169	
	10% level	-2.600658	

*MacKinnon (1996) one-sided p-values.

Both these tests confirm that the residual is stationary. Therefore, this model appears properly specified as:

$$\text{Log}(GDP_t) - \text{Log}(GDP_{t-1}) = \underset{(.04)}{.21} * [\text{Log}(Capital_t) - \text{Log}(Capital_{t-1})] + \underset{(.11)}{.66} * [(\text{Log}(Labor_t) - \text{Log}(Labor_{t-1})] + \varepsilon_t \quad \text{eq. [4]}$$

From the discussion above, apartheid existed from 1961 to 1993 and ended in 1994. To account for the official end of the apartheid policies a dummy variable with zeros from 1970 (first year constant dollars available) to 1993 and ones from 1994 to 2017 was created and added to the model specification. This variable was first differenced as required for proper specification. Here is the revised model:

$$Log(GDP_t) - Log(GDP_{t-1}) = \alpha*[Log(Capital_t) - Log(Capital_{t-1})]$$

$$+ \beta*[(Log(Labor_t) - Log(Labor_{t-1})] + \zeta * [\Delta Apartheid_t - \Delta Apartheid_{t-1}]+ \varepsilon_t \quad \text{eq. [5]}$$

This new model including the intervention dummy variable was estimated using ordinary least squares methodology. Here are the results:

Variable	Coefficient	Standard Error
Capital	0.21***	0.04
Labor	0.67***	0.11
Apartheid	-0.01	0.02
R-squared	0.38	
Durbin-Watson statistic	1.89	

***P<.01; **P<.05; *P<.10

The α and β coefficients for Capital and Labor are significant to a .01 level and in a direction which is in accordance with theory. The dummy variable for the end of the apartheid policies was **NOT** significant. In order to observe the impact from lagging and delaying the intervention, several different intervention years were analyzed. All other the coefficients and standard errors for the Capital and Labor variables remained relatively the same while none of the alternative interventions were generally significant or directional correct. See table below:

	Capital / Labor		Apartheid	
Year	Coefficient / Standard Error		Coefficient	Standard Error
1992			-0.03	0.02
1993	Average		-0.01	0.02
1994	0.20	0.68	-0.01	0.02
1995			-0.01	0.02
1996			0.01	0.02

Therefore, it cannot be said that, after controlling for the factors of production, the rate of change in GDP was impacted by the dismantling of the apartheid system. Because the apartheid variable was the specification of interest and because it was not significant, no additional analysis related to this model was conducted.

Model interpretation

A brief comment on the interpretation of this model should is appropriate. By logarithmically transforming the GDP, Capital, and Labor variables and then taking their first differences, these variables were converted into elasticities. Elasticity indicates responsiveness between variable. That is, the amount of fractional change in one variable that will occur given the fractional change in another variable. Therefore, the β coefficient for Labor of .66 indicates that if Labor goes up by 1%, on average, the amount of GDP goes up about .66%. Similarly, the α coefficient of .21 for capital indicates that a 1% increase in capital will result in GDP increasing .21%.

Conclusion

In conclusion, the Cobb-Douglas appears properly stated and significant for the SA economy, excluding the apartheid intervention, as follows:

$$\underset{(.11)}{.66} * [(\text{Log}(\text{Labor}_t) - \text{Log}(\text{Labor}_{t-1})] + \underset{(.04)}{.21} * [\text{Log}(\text{Capital}_t) - \text{Log}(\text{Capital}_{t-1})] + \varepsilon_t \qquad \text{eq. [4]}$$

This analysis did not demonstrate an impact on the Cobb-Douglas model after the removal of the apartheid system. Perhaps this is not surprising. The Cobb-Douglas model may have controlled for enough of the major factors of production such that there is little left for the end of apartheid to explain. Future analysis might be conducted to review what impact apartheid had on the factors of production.

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