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Abstract

This paper analyses the importance of competitiveness factors in international competitiveness ranking of South Africa. In particular, the paper investigates the odds in favour of an improved, as opposed to a deteriorated, Overall international competitiveness ranking due to a change in selected competitiveness factors. The results show that the autonomous improvement in Overall international competitiveness ranking is statistically insignificant while the effect of a change in Government efficiency also has a statistically insignificant effect on the odds in favour of an improved Overall international competitiveness ranking. The results further show that a change in Economic performance, Business efficiency and Infrastructure increase the odds in favour of an improved Overall international competitiveness ranking. Finally, a change in Infrastructure has the biggest odds in favour of an improvement in Overall international competitiveness ranking compared to a change in Economic performance and Business efficiency.

JEL Classification: C12, E02, F23, I31
Keywords: Competitiveness factors, International competitiveness ranking

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Introduction

One of the key objectives of economic development policy is to increase the nation's competitiveness in domestic and international markets in order to attain improved welfare and prosperity for the citizens. Improving national welfare and prosperity have dominated economic thought since the classical theories of absolute and comparative advantage by Adam Smith and David Ricardo. The subsequent theories of factor endowments were developed by Heckscher and Ohlin while Joseph Schumpeter and Robert Solow emphasised entrepreneurship and technological innovation as engines of economic development. Recent contributions include the theory of competitive advantage by Porter (1990) as well as the compendium of international competitiveness statistics by institutions such as the Institute for Management Development (IMD), the World Economic Forum (WEF) and the World Bank (WB) and unpublished rankings by governments and research institutions. The IMD World Competitiveness Center (2014) defines competitiveness as the "ability of a nation to create and maintain an environment that sustains more value creation for its enterprises and more prosperity for its people." while it also contends that competitiveness is a process which is achieved at different levels, such as, at firm, regional and national levels.

International competitiveness of nations is deemed vital for a nation's prosperity as argue Bris (2017). However, significant scepticism has been leveled against the rationale of international competitiveness as a concept as well as its measurement. Krugman (1994) argues that "competitiveness is a meaningless word when applied to national economies." while Kliesen and Krugman (1995) argue that "...the idea of countries competing with one another on the economic battlefield is a dubious concept." Thus Krugman (1996) contends that firms, not nations, need to be competitive. Nevertheless, the recent past has witnessed a growing academic and political debate over better ways to conceptualise and measure international competitiveness of nations. The recent literature identify several factors as being important for a nation's international competitiveness. Over and above the usual measures such as production efficiency, terms of trade, wage rates and the exchange rates, Dixit and Norman (1980), Freeman (2004), Balkyte and

Tvaronaviciene (2010) and Porter (2011) identify product and process innovation as well as institutional and societal framework as vital ingredients for international competitiveness. Berger (2008), Kharlamova and Vertelieva (2013), Solvell (2015) and Ketels (2016) explore issues of international competitiveness as a concept while Buckley et al. (1988) and Aktas et al. (2008) explore the caveats that include the lack of consensus on how international competitiveness can be measured, the inexhaustible list of determinant factors and the inadequacy of a coherent economic theory that explain national competitiveness.

This paper analyses the importance of competitiveness factors in international competitiveness ranking of South Africa. This is achieved by constructing the variables as deviations from their long term trends. The important factors in Overall international competitiveness ranking are analysed using the binomial logistic regression model. As such, the Overall international competitiveness ranking variable is transformed into a dummy variable of 2 mutually exclusive categories of improved performance ranking as well as deteriorated performance ranking. Thus the paper will infer the odds in favour of an improved as opposed to a deteriorated Overall international competitiveness ranking due to a change in the competitiveness factors. Understanding the important factors in Overall international competitiveness ranking is important because the concept of international competitiveness has gained importance in recent decades from the viewpoint of economic growth and development of nations. Thus an analysis and assessment of a nations international competitiveness will enhance the performance of policy makers, both in government and business, to design industrial and business best practices in international competitiveness.

The paper is organised as follows. The next section discusses data. This is followed by the specification of the econometric model. Then its the discussion of the results and last is the conclusion

Data

Annual data spanning the period 1997 to 2017 is used. The data is sourced from the World Competitiveness Center database by the Institute for Management Development (IMD). The data comprises Overall performance, Economic performance, Government efficiency, Business efficiency and Infrastructure. According to IMD World Competitiveness Yearbook (2016), Overall performance is the composite indicator of four factors that comprise Economic performance, Government efficiency, Business efficiency and Infrastructure. Economic performance is the macroeconomic evaluation of the domestic economy, employment trends and prices. Business efficiency is the extent to which government policies are conducive to competitiveness. Government efficiency is the extent to which the national environment encourages enterprises to perform in an innovative, profitable and responsible manner. Infrastructure is the extend to which basic, technological, scientific and human resources meet he needs of businesses.

Table 1 shows the descriptive statistics of the variables. Overall performance is strongly positively correlated with Economic performance and Infrastructure in ascending order of importance. There is also a moderate to strong positive correlation between Overall performance and Business efficiency while the correlation between Overall performance and Government efficiency is relatively weak. Overall performance recorded a weakest ranking of 53 in 2017, 2015 as well as in 2009 while the strongest ranking in the indicator was realised in 2002 and 2006 at 37. Among the four factors, the weakest ranking was recorded by Economic performance and Infrastructure 58 in 2017 and 2013 respectively while the strongest ranking was realised in Government efficiency and Business efficiency at 21 and 23 in 2010 and 2000 respectively. The weakest average ranking was recorded in Infrastructure at about 51 while strongest average raking was recorded in Government efficiency at about 32. The highest volatility was recorded in Business efficiency and Government efficiency while the opposite is true for Infrastructure.

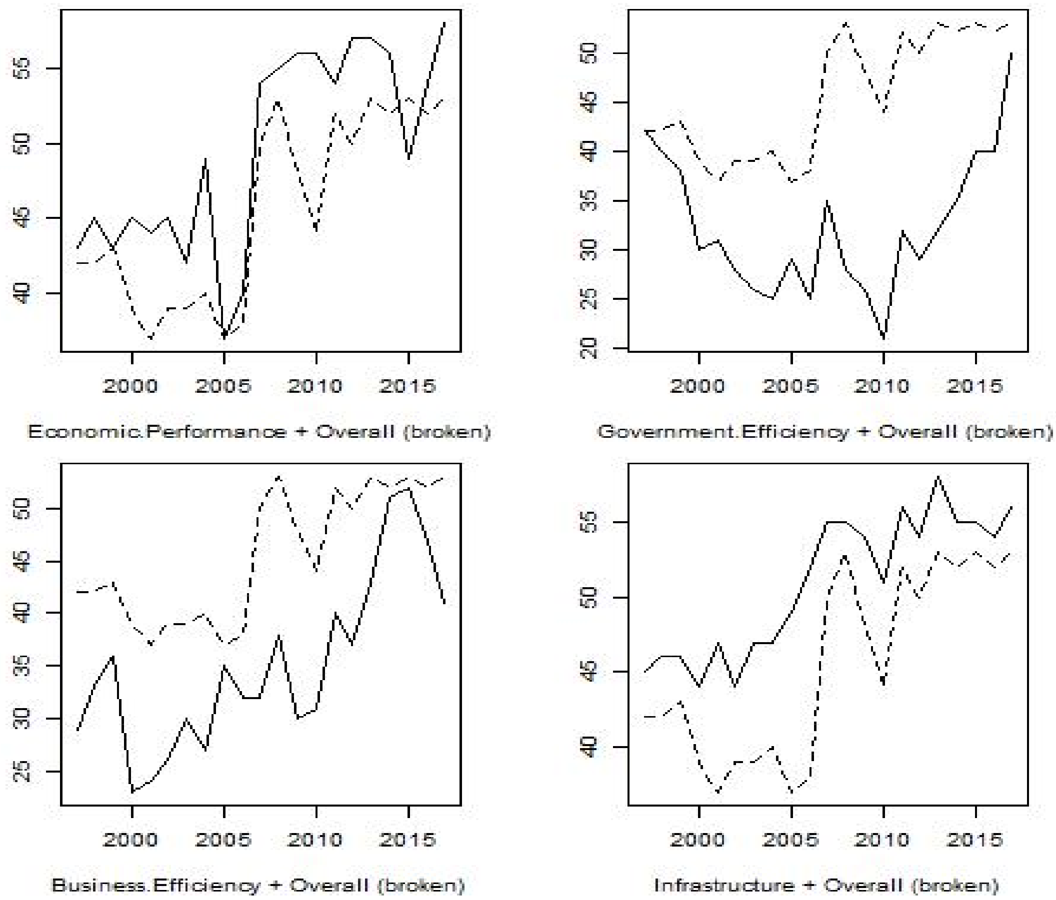
	Corr.	Max.	Mean	Min.	St. dev.
Overall performance	1.000000	53.000000	45.52381	37.000000	6.281871
Economic performance	0.848666	58.000000	49.47619	37.000000	6.637914
Government efficiency	0.406061	50.000000	32.47619	21.000000	7.110689
Business efficiency	0.784157	52.000000	35.09524	23.000000	8.251695
Infrastructure	0.862246	58.000000	50.95238	44.000000	4.620348

Notes: Own estimations with data from the IMD World Competitiveness Center database. Corr. is the correlation coefficient and measures the strength of linear association between pairs of variables, Max. is maximum observation of a variable, Mean is the average value of the observations of a variable, Min. is the minimum value of a variable while St. dev. the standard deviation of a variable.

Table 1: Descriptive statistics of the variables

According to the IMD World Competitiveness Center (2017), the IMD World Competitiveness Yearbook is an annual report on the international competitiveness of countries. It is published by the Swiss based International Institute for Management Development (IMD) since 1989. The IMD World Competitiveness Yearbook of 2017 benchmarked 63 economies based on 4 factors, 20 sub factors and 346 criteria measuring different facets of competitiveness that comprise Overall performance, Economic performance, Government efficiency, Business efficiency and Infrastructure. Bris and Cabolis (2017) argue that the methodology in the combination of 2 thirds hard statistical data that is sourced from international and national sources as well as one third survey data that relies on executive opinion survey. According to the IMD World Competitiveness Center (2014), measuring international competitiveness helps policy makers and analysts to understand the factors that facilitate prosperity and goes beyond the economic performance of a country to encompass a variety of economic as well as non economic dimensions.

Figure 1 shows the plots of the variables. Overall performance ranking deteriorated somewhat from 1997 to 1999 and realised an improvement in ranking between 2000 and 2001. The indicator remained relatively range bound between 2001 and 2006 before it recorded a sharply deteriorated ranking reaching a low in 2008. This was followed by a slight improvement in 2009 and 2010 before another deterioration in ranking in 2011. The indicator then realised a steady deterioration between 2011 and 2017 and recorded the weakest ranking towards the end of the sample in 2017 following a slightly improved performance in 2015. Economic performance deteriorated slightly between 1997 and 1999. The indicator then improved between 2000 and 2001 following which it remained range bound between 2002 and 2005. The indicator experienced some volatility from 2000 and reached an all time strongest ranking in 2005. Its ranking then decreased significantly between 2005 and 2007, improved to 2010 but subsequently remained range bound from 2011 to the end of the sample where it recorded the weakest ranking in 2017.



Notes: Graphs use data from the IMD World Competitiveness Center database. The left hand scale measures a country's international competitiveness ranking out of 63 countries. Overall performance is the composite indicator of four competitiveness factors that comprise Economic performance, Government efficiency, Business efficiency and Infrastructure. Refer to the text for more details on the competitiveness factors.

Figure 1: Plots of the variables

Government efficiency recorded a consistently improved ranking between 1997 and 2010 saving the somewhat significant deterioration that was realised in 2007. The indicator subsequently deteriorated sharply between 2010 and 2017 recording an all time weakest ranking in 2017. Business efficiency realised a deteriorating ranking between 1997 and 1999. The ranking of the indicator then improved sharply between 1999 and 2000 where it subsequently realised sustained but volatile deterioration between 2000 recording an all time weakest ranking in 2015. The indicator then recorded an improved ranking between 2015 and 2017. Infrastructure recorded a range bound ranking between 1997 and 2002. The indicator subsequently realised consistent deterioration in ranking between 2002 and 2013 saving the slight improvement between 2007 and 2010. The indicator recorded an improvement in ranking between 2014 and 2016 but deteriorated in ranking again 2017. Overall, most of the indicators followed the movements in Overall performance ranking to varying degrees given that they constitute the indicator.

Methodology

The importance of competitiveness factors in Overall international competitiveness ranking is analysed using the binomial logistic regression model. According to Pampel (2000) and Bingham and Fry (2010), the binomial logistic regression model is part of a larger class of models known as Generalized Linear Models (GLM). Baker and Nelder (1972) and Nelder and Wedderburn (1972) proposed this model to provide a means of estimating regression problems that are not directly suited for application of a linear regression model. According to Gujarati (2003) and Torres-Reyna (2014), GLM does not assume a linear relationship between the dependent and independent variables. As such, GLM does not use Ordinary Least Squares (OLS) estimation but uses maximum likelihood estimation (MLE). The dependent variable need not to be normally distributed and the errors need to be independent but not normally distributed. Thus the binomial logistic regression model is a regression model in which the dependent variable is qualitative in nature where the dependent variable is a binary, dichotomous or dummy variable.

Following Pampel (2000) and Gujarati (2003), consider the following linear regression model

$$Y_t = \beta_0 + \beta_1 X_t + \epsilon_t \tag{1}$$

where Y_t is the dependent variable, β_t are coefficients, X_t are independent variables, t is a time subscript and ϵ_t is the *iid* error term. According to Gujarati (2003) and Torres-Reyna (2014), in the event that the independent variable Y_t is quantitative in nature, its expected or mean value is estimated given the values of the regressors whereas in the event that the independent variable Y_t is binary, dichotomous or dummy in nature, its probability value is estimated hence qualitative response models are also known as probability models.

When Y_t is binary, dichotomous or dummy in nature where $Y = 1$ if an event occurs and $Y = 0$ otherwise, the conditional expectation of Y_t given X_t is

$$P_t = E(Y_t = 1|X_t) = \beta_0 + \beta_1 X_t \tag{2}$$

where P_t is the probability that $Y_t = 1$ and and $1 - P_t$ is the probability that $Y_t = 0$, $E(\epsilon_t) = 0$ and $0 \leq E(Y_t|X_t) \leq 1$ since the probability P_t must lie between 0 and 1. The model is a linear probability model (LPM) because the independent variable Y_t is binary, dichotomous or dummy in nature and hence it follows a binomial or Bernoulli probability distribution.

The cumulative distribution function (CDF) where the independent variable Y_t is is binary, dichotomous or dummy in nature resembles the sigmoid curve hence models are the logistic and the normal. According to Gujarati (2003), the logistic CDF gives rise to the logit model and normal CDF to the normit, or probit, model. Assuming a logistic CDF of the independent variable Y_t, the Equation 2 can be rewritten as

$$P_t = E(Y_t = 1|X_t) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 X_t)}} \tag{3}$$

where Equation 3 is the cumulative logistic regression function. P_t is nonlinearly related to X_t such that $0 \leq P_t \leq 1$ and $-\infty \leq \beta_0 + \beta_1 X_t \leq \infty$. The probability that an event occurs $Y_t = 1$ is $P_t = E(Y = 1 \mid X_t)$ so that the probability that $Y_t = 0$ is

$$(1 - P_t) = E(Y = 0 \mid X_t) = \frac{1}{1 + e^{(\beta_0 + \beta_1 X_t)}} \tag{4}$$

where $(1 - P_t)$ is a probability that an event does not occur.

Dividing Equations 3 by Equation 4 achieves

$$\frac{P_t}{(1-P_t)} = \frac{1+e^{(\beta_0+\beta_1 X_t)}}{1+e^{-(\beta_0+\beta_1 X_t)}} = e^{(\beta_0+\beta_1 X_t)} \tag{5}$$

where $\frac{P_t}{1-P_t}$ is the odds ratio in favour of $Y = 1$ and against $Y = 0$. The odds ratio measures the probability that an event occurs against that of an event does not occur. Applying the natural logarithm on Equation 5 gives

$$L(\beta_t) = \ln\left(\frac{P_t}{1-P_t}\right) = \beta_0 + \beta_1 X_t \tag{6}$$

where $L(\beta_t)$ is the log of odds ratio and is linear in parameters β_t as well as in the independent variables X_t. $L(\beta_t)$ follows the logit, or logistic, distribution and hence the model is the logit, or logistic, regression model and is binomial because the dependent variable is a binary, dichotomous or dummy variable.

The binomial logistic regression model cannot be estimated using standard Ordinary Least Squares hence Maximum Likelihood Estimation (MLE) is used to estimate the parameters of the model. Therefore determining the log likelihood function which is the joint probability density function of observable random variables becomes important. Given the probability P_t is the probability that $Y_t = 1$ or that an event occurs, the likelihood function is

$$L(\hat{\beta}) = \Pi_{t=1}^{n} P_t^{Y_t} (1-P_t)^{1-Y_t} \tag{7}$$

where n is the sample period. Taking the logarithm of the likelihood function $L(\beta)$ gives.

$$\ln L(\hat{\beta}) = \sum_{t=1}^{n} Y_t \ln P_t + \sum_{t=1}^{n} (1-Y_t) \ln (1-P_t) \tag{8}$$

which is the the log likelihood function. Maximizing the log likelihood function $\ln L(\beta)$ obtains the maximum likelihood estimates of the model parameters β.

Given that the binomial logistic regression model is binomial in nature, the dependent variable is a binary, dichotomous or dummy variable hence Overall performance is transformed into a dummy variable. The 2 mutually exclusive categories into which Overall performance is transformed are improved performance ranking as well as deteriorated performance ranking. The improved performance ranking $Y_t = 1$ approximates the upward phase of Overall performance cycle while deteriorated performance ranking $Y_t = 0$ approximates the downward phase of Overall performance cycle. Overall performance cycle is constructed as the deviation of Overall performance indicator from its Hodrick and Prescott (1997) trend. 3 years are forecasted at the end of the Overall performance indicator data series to correct the end point problem following Ravn and Uhlig (2002) and Mise et al. (2005). As with Overall international performance variable, the competitiveness factors that comprise Economic performance, Government efficiency, Business efficiency and Infrastructure were constructed as the deviation of from their Hodrick and Prescott (1997) trend together with the end point correction.

The Hodrick and Prescott (1997) filter isolates the trend or the permanent component of the data series Y_t from the cycle or the short to medium term component as

$$Y_t = \bar{Y}_t + \tilde{Y}_t \tag{9}$$

where $\bar{Y}_t$ is the permanent component of the data series while $\tilde{Y}_t$ is the short to medium term component. The Hodrick and Prescott (1997) filter computes trend and cycle components $\tau_{t=1}^{n}$ and $c_{t=1}^{n}$ from the solution to the optimization problem

$$\min_{(\bar{Y}_t)_t^n} \left(\sum_{t=1}^{n} (Y_t - \bar{Y}_t)^2 + \lambda \sum_{t=2}^{n-1} (\Delta^2 \bar{Y}_t)^2 \right) \tag{10}$$

where Δ is the differencing operator and $0 < \lambda < \infty$ a smoothing parameter where $\bar{Y}_t$ approaches the time series Y_t when $\lambda \to 0$ and $\bar{Y}_t$ is a linear time trend of the series Y_t when $\lambda \to \infty$. Orphanides and Williams (2002) and Hamilton (2017) argue that the Hodrick and Prescott (1997) filter remains popular for decomposing an economic variables into the trends and cycles components despite its drawbacks.

Results

The import factors in Overall performance ranking were analysed using the binomial logistic regression model. As described above, the variables were constructed as deviations from their Hodrick and Prescott (1997) trends. The Overall international competitiveness ranking variable was then transformed into a dummy variable of 2 mutually exclusive categories of improved performance ranking against a deteriorated performance ranking. The rationale was to isolate the permanent component of the data series from the short to medium term component. As discussed in Mashabela and Raputsoane (2018), the short to medium term economic fluctuations usually manifest due to changes in demand side economic policies such as monetary, financial and fiscal policies and innovation as well as changes in supply side policies that affect labour market flexibility and enterprise investment. The long term economic fluctuations usually manifest due to changes in supply side policies that affect deregulation, removal of restrictions, privatisation, multilateral agreements, technological advancement and changes in the structure of global economy. The variables were then interpolated from annual frequency to quarterly frequency on sample size consideration. A cubic spline interpolation method is used to to convert the variables from low to high frequency. A detailed discussion of the economic cycle can be found in King et al. (1991), Nelson and Plosser (1982) and Kydland and Prescott (1990) while discussions on microeconomic and macroeconomic policy interaction over the economic cycle can be found in Blanchard et al. (1986).

The decomposition of the data series into the Hodrick and Prescott (1997) cyclical component means that the paper analyses the importance of short to medium term competitiveness factors. As discussed above, the short to medium term component of an economic variable describes the idiosyncratic shocks and changes in demand side economic policies hence the paper ignores the effects of the permanent shocks and changes in supply side policies whose effects take longer to manifest. This is important for policy making purposes because the effect of different policies on target variables differ depending on whether they are demand side and supply side policies. As discussed in Mashabela and Raputsoane (2018), the duration of the short to medium term component of the data series is 5 to 10 years while the duration of the permanent component is a period of more than 10 years. As such, the demand side economic policies are realised in the short to medium term, which is explained by the transitory and idiosyncratic component of the variables while the supply side economic policies are realised in the long term, which is explained by the permanent component of the variables. The Hodrick and Prescott (1997) filtered Overall performance variable is transformed into a dummy variable where it assumes a value of 1 when its cyclical component is above its long term trend and the value of 0 otherwise. Thus improved performance ranking is a value of 1 while a value of 0 approximates deteriorated performance ranking.

The binomial logistic regression model is estimated using Maximum Likelihood Estimation (MLE). Following Hosmer et al. (1997) and Pregibon (1981), the diagnostic statistics that include the log likelihood, McFadden (1973) pseudo R^2, Akaike (1974) Information Criteria (AIC) as well as the null deviance and residual deviance are used to evaluate the performance of the model. Table 2 reports the diagnostic statistics of the binomial logistic regression model. The log likelihood which measures the joint probability density function of observable random variables is -10.481330. The Akaike (1974) Information Criteria (AIC) which is the measure of fit that penalises the model for the number of model coefficients is 30.96300. The McFadden (1973) pseudo R^2 is 0.819910 and is relatively high hence there is evidence that the independent variables adequately explain the dependent variable. The null deviance which measures the response predicted by the model with nothing but the intercept term is 116.401000 while the residual deviance which measures the response predicted by a model on adding the independent variables is 20.96300. This implies the model with the added independent variables is preferred given that its predicted response is lower than the response predicted by a model with nothing but an intercept term.

Statistic	Value	Statistic	Value
Log likelihood	-10.481330	Null deviance	116.401000
Akaike info. Crit.	30.963000	Residual deviance	20.963000
Pseudo R^2	0.819910	Observations	84.000000

Notes: Own estimations with data from the IMD World Competitiveness Center database. Log likelihood measures the joint probability density function of observable random variables, Akaike info. Crit. is the Akaike (1974) Information Criteria (AIC) and is the measure of fit that penalises the model for the number of model coefficients, Pseudo R^2 is the McFadden (1973) pseudo R^2 and measures the how well the independent variables explain the variance in the dependent variable, Null deviance measures the response predicted by the model with nothing but the intercept term, Residual deviance measures the response predicted by a model on adding the independent variables, Observations is the sample size.

Table 2: Diagnostic statistics of the binomial logistic regression model

Table 3 reports the results of the binomial logistic regression model. The results comprise the log of odds ratio of the coefficients as well as the odds ratio which is the antilog of the log of odds ratio of the coefficients. The marginal effects measure the percentage change in the odds for a unit change in the coefficient. The z statistics are the regression coefficients divided by their respective standard errors and tests the null hypothesis that a particular coefficient is equal to zero. The probability value measures the exact significance level at which a null hypothesis can be rejected. The importance of the competitiveness factors in determining the Overall performance ranking are evaluated using the significance level of 5 percent consistent with the normal practice in empirical economics. In this paper, the odds ratio and the marginal effects of the estimated coefficients will be interpreted. Although reported, the log odds ratios are not interpreted because their interpretation is normally not be intuitively appealing. Thus the odds in favour of an increase in Overall performance ranking due to a change in the competitiveness factors, which is synonymous with the the percentage change in in Overall performance ranking for a unit change in the competitiveness factors as inferred from the marginal effects will be examined.

The results generally show an improvement in the Overall performance ranking due to a change in competitiveness factors as well as when the competitiveness factors do not change. However, as discussed below, the autonomous improvement in Overall performance ranking as well as the effect of a change in Government efficiency are not statistically significant. Keeping the competitiveness factors constant, the odds in favour of a deterioration in the Overall performance ranking is higher by 5.755754 units or about 12.465400 percentage points. However, the coefficient is statistically insignificant which implies that the Overall performance ranking does not significantly change significantly when the competitiveness factors are kept constant. The effect of the change in Government efficiency on the Overall performance ranking is also statistically insignificant. This implies that the change in Government efficiency does not significantly effect on the Overall international performance ranking during the sample period.

	Log odds	Odds ratio	Marg. eff.	z value	p value
Intercept	1.750200	5.755754	0.124654	1.551000	0.121000
Economic performance	1.824300	6.198290	0.134238	1.934000	0.053200
Government efficiency	0.008600	1.008640	0.000633	0.043000	0.965300
Business efficiency	1.796700	6.029800	0.132210	2.077000	0.037800
Infrastructure	2.838900	17.097560	0.208901	2.232000	0.025600

Notes: Own estimations with data from the IMD World Competitiveness Center database. Log odds is the logarithm of odds ratio of the coefficients, Odds ratio is the antilog of the logarithm of odds ratio of the coefficients, Marg. eff. are the marginal effects and measure percentage change in the odds for a unit increase in the coefficient, z value is the regression coefficient divided by its standard error and tests the null hypothesis that the coefficient is equal to zero and p value is the 2 tailed measure of significance and measures the exact significance level at which a null hypothesis can be rejected.

Table 3: Regression results of the binomial logistic regression model

When Economic performance increases by 1 unit, the odds in favour an improved Overall performance ranking increase by 6.198290 units or about 13.423800 percentage points. The coefficient is statistically significant which implies that the change in Economic performance indeed leads to a significant improvement in Overall performance ranking. When Business efficiency increases by 1 unit, the odds in favour an improved Overall performance ranking increase by 6.029800 units or about 13.221000 percentage points. The coefficient is statistically significant which implies that the change in Business efficiency actually leads to a significant improvement in Overall performance ranking. When Infrastructure increases by 1 unit, the odds in favour an improved Overall performance ranking increase by 17.097560 units or about 20.890100 percentage points. The coefficient is statistically significant which implies that the change in Infrastructure surely leads to a significant improvement in Overall performance ranking.

The results have shown that the autonomous improvement in Overall international performance ranking as well as the effect of a change in Government efficiency are statistically insignificant. The statistically insignificant autonomous improvement in Overall performance ranking is not surprising given that the indicator is a composite indicator of the competitiveness factors. The statistically insignificant effect of Government efficiency on improvement in Overall international performance ranking is interesting given that government is normally expected to create an enabling environment for the economy through the adoption of business friendly policies as well as ensuring that proper Infrastructure is in place. The results also show that a change in Economic performance, Business efficiency and Infrastructure lead to the improvement in Overall international performance ranking. A change in Infrastructure has the biggest impact on improvement in Overall international performance ranking compared to a change in Economic performance as well as Business efficiency both whose impact is almost similar in magnitude.

Conclusion

This paper investigated the the importance of competitiveness factors in international competitiveness ranking of South Africa using the binomial logistic regression model. The variables were constructed as deviations from their long term trends. Then the Overall competitiveness ranking variable was transformed into a dummy variable of 2 mutually exclusive categories of improved and deteriorated performance ranking. Thus the paper inferred the odds in favour of an improved as opposed to a deteriorated Overall international competitiveness ranking due to a change in the competitiveness factors. The results have shown that the autonomous improvement in Overall international competitiveness ranking is statistically insignificant while the effect of a change in Government efficiency also has a statistically insignificant effect on the odds in favour of an improved Overall international competitiveness ranking. The results have also shown that a change in Economic performance, Business efficiency and Infrastructure lead to an increase in the odds in favour of an improved in Overall international competitiveness ranking. Finally, a change in Infrastructure had the biggest odds in favour of an improvement in Overall international competitiveness ranking compared to a change in Economic performance and Business efficiency.

References

Akaike, H. (1974). A New Look at the Statistical Model Identification. *IEEE Transactions on Automatic Control*, 19(6):716–723.

Aktas, E., Kabak, O., Onsel, S., Ulengin, F., Ulusoy, G., and Topcu, Y. I. (2008). A New Perspective on the Competitiveness of Nations. *Socio Economic Planning Sciences*, 42(4):221–246.

Baker, R. J. and Nelder, J. A. (1972). *Generalized Linear Models*. Wiley Online Library.

Balkyte, A. and Tvaronaviciene, M. (2010). Perception of Competitiveness in the Context of Sustainable Development: Facets of Sustainable Competitiveness. *Journal of business economics and management*, 11(2):341–365.

Berger, T. (2008). Concepts of National Competitiveness. *Journal of International Business and Economy*, 9(1):91–111.

Bingham, N. and Fry, J. M. (2010). Generalised Linear Models. In Bingham, N. and Fry, J. M., editors, *Regression*, pages 181–201. Springer.

Blanchard, O. J., Hall, R. E., and Hubbard, R. G. (1986). Market Structure and Macroeconomic Fluctuations. *Brookings Papers on Economic Activity*, 1986(2):285–338.

Bris, A. (2017). Message from the IMD World Competitiveness Center Director. *Brochure*. Institute for Management Development (IMD).

Bris, A. and Cabolis, C. (2017). How does IMD World Competitiveness Center Prepare Data for the Competitiveness Rankings. *Manual*. Institute for Management Development (IMD).

Buckley, P. J., Pass, C. L., and Prescott, K. (1988). Measures of International Competitiveness: A Critical Survey. *Journal of Marketing Management*, 4(2):175–200.

Dixit, A. and Norman, V. (1980). *Theory of International Trade: A Dual, General Equilibrium Approach*. Cambridge University Press.

Freeman, C. (2004). Technological Infrastructure and International Competitiveness. *Industrial and Corporate Change*, 13(3):541–569.

Gujarati, D. N. (2003). *Time Series Analysis*. McGraw Hill, New York, 4th edition.

Hamilton, J. D. (2017). Why You Should Never Use the Hodrick Prescott Filter. *Review of Economics and Statistics*, 0(ja).

Hodrick, R. and Prescott, E. C. (1997). Postwar U.S. Business Cycles: An Empirical Investigation. *Journal of Money, Credit and Banking*, 29(1):1–16.

Hosmer, D. W., Hosmer, T., Le Cessie, S., Lemeshow, S., et al. (1997). A Comparison of Goodness of Fit Tests for the Logistic Regression Model. *Statistics in Medicine*, 16(9):965–980.

IMD World Competitiveness Center (2014). *IMD World Competitiveness Yearbook 2014*. Institute for Management Development (IMD), Switzerland.

IMD World Competitiveness Center (2017). *IMD World Competitiveness Yearbook 2017*. Institute for Management Development (IMD), Switzerland.

IMD World Competitiveness Yearbook (2016). *Frequently Asked Questions*. Institute for Management Development (IMD), Switzerland.

Ketels, C. (2016). *Review of Competitiveness Frameworks*. National Competitiveness Council. Dublin.

Kharlamova, G. and Vertelieva, O. (2013). The International Competitiveness of Countries: Economic-Mathematical Approach. *Economics and Sociology*, 6(2):39.

King, R., Plosser, C. I., Stock, J. H., and Watson, M. W. (1991). Stochastic Trends and Economic Fluctuations. *American Economic Review*, 81(4):819–840.

Kliesen, K. L. and Krugman, P. (1995). The Fixation on International Competitiveness. *The Regional Economist*, Jan:4–9.

Krugman, P. R. (1994). Competitiveness: A Dangerous Obsession. *Foreign Affairs*, 73(2):28–44.

Krugman, P. R. (1996). Making Sense of the Competitiveness Debate. *Oxford Review of Economic Policy*, 12(3):17–25.

Kydland, F. E. and Prescott, E. C. (1990). Business Cycles: Real Facts and a Monetary Myth. *Quarterly Review*, 4:3–18. Federal Reserve Bank of Minneapolis.

Mashabela, J. and Raputsoane, L. (2018). The Behaviour of Transitory and Potential Disaggregated Output Over the Economic Cycle. *Working Paper*, 84422. Munich Personal RePEc Archive.

McFadden, D. (1973). Conditional Logit Analysis of Qualitative Choice Behavior. In Zarembka, P., editor, *Frontiers in Econometrics*, pages 105–142. Academic Press.

Mise, E., Kimand, T., and Newbold, P. (2005). On Suboptimality of the Hodrick Prescott Filter at Time Series Endpoints. *Journal of Macroeconomics*, 27(1):53–67.

Nelder, J. A. and Wedderburn, R. W. M. (1972). Generalized Linear Models. *Journal of the Royal Statistical Society*, 135(3):370–384.

Nelson, C. R. and Plosser, C. R. (1982). Trends and Random Walks in Macroeconomic Time Series: Some Evidence and Implications. *Journal of Monetary Economics*, 10(2):139–162.

Orphanides, A. and Williams, J. C. (2002). Robust Monetary Policy Rules with Unknown Natural Rates. *Brookings Papers on Economic Activity*, 2002(2):63–118.

Pampel, F. C. (2000). *Logistic Regression: A Primer*, volume 132. Sage Publications.

Porter, M. E. (1990). The Competitive Advantage of Nations. *Competitive Intelligence Review*, 1(1):14–14.

Porter, M. E. (2011). *Competitive Advantage of Nations: Creating and Sustaining Superior Performance*, volume 2. Simon and Schuster.

Pregibon, D. (1981). Logistic regression diagnostics. *The Annals of Statistics*, pages 705–724.

Ravn, M. O. and Uhlig, H. (2002). On Adjusting the Hodrick Prescott Filter for the Frequency of Observations. *Review of Economics and Statistics*, 84(2):371–376.

Solvell, O. (2015). The Competitive Advantage of Nations 25 Years: Opening up New Perspectives on Competitiveness. *Competitiveness Review*, 25(5):471–481.

Torres-Reyna, O. (2014). *Getting Started in Logit and Ordered Logit Regression*, volume 3.1. Data and Statistical Services. Princeton University.