Modelling the Impact of Automatic Fiscal Stabilisers on Output Stabilisation in South Africa

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Abstract

This paper investigates ways in which an efficiency model like 'DEA Window analysis' can be utilised, under strictly defined conditions, to assess the level of efficiency of automatic fiscal stabilisers (AFS). The size of AFS is obtained through gaps in both revenue and expenditures variables such as tax revenue (current tax on income and wealth), social grants/benefits, and compensation of employees. The results obtained support evidence of AFS action between 1991 and 2005 and explain distinct cointegrating vectors that exist between the obtained efficiency scores and some selected variables, such as a corruption perception index (CPI), a conversion factor (exports), and the level of openness in the economy.

KEYWORDS: South Africa; Automatic Fiscal Stabilisers; Data Envelopment Analysis; Efficiency scores.

JEL CODE: C10; E62; H24

1 Introduction

For several years, the literature on Public Economics has been characterised by a lively debate on whether automatic fiscal stabilisers play a meaningful role in stabilising the business cycle. The sensitivity of the public sector budget balance to business cycle fluctuations in particular has received much attention. The role of automatic stabilisers in budget analysis has also become part of the debate (OECD, 1999). In the 2008 Budget Review, the National Treasury of South Africa also expressed interest in cyclically adjusted budget analysis.

Automatic fiscal stabilisers (AFS) consist of economic variables, such as taxes and unemployment benefits that operate in a direct manner in response to cyclical fluctuations. However, it seems that the role played by AFS does not receive much attention in less developed countries, probably because key variables that portray the automatic fiscal stabilisation effect, such as unemployment benefits, are virtually non-existent (or at the very beginning of the implementation stages).

A priori expectations regarding evidence of automatic stabilisation is based on the fact that government net lending is sensitive to output fluctuations (a Johansen approach) - the first indication of the presence of automatic stabilisers within the economy (OECD, 1999). This paper attempts to measure and assess the effectiveness of AFS in output gap stabilisation for the South African economy.

The methodology used to assess the efficiency of AFS variables over the considered time period (1991 − 2005) is the Data Envelopment Analysis (DEA) while a VAR approach is used to evaluate the counter-cyclical demand impulse stemming from the working of AFS in the economy. Different gaps are computed using an exponential smoothing filter that produces more accurate results than

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the traditional Hodrick Prescott technique. DEA has revealed itself to be one of the most referred to non-parametric efficiency methods used in the public or non-profit making sectors, the reason being that it does not require *a priori* specification and can be performed on an unlimited number of outputs and inputs at once. No study on the impact of AFS on output stabilisation using DEA could be located, although some researchers have been using other efficiency methods such as Free Disposal Hall (FDH), Malmquist Productivity Index (MPI), and Stochastic Frontier Analysis (SFA). In this paper, flexible techniques are used to remove outliers from the sample size (Holt Winters exponential smoothing technique). The SFA method does not allow for the use of a multiple output approach and the use of the MPI method has not been considered because it does not allow for the efficiency of a DMU to be calculated individually and instead requires a balanced panel of quantitative data.

Regional integration requires country differential information in terms of AFS. As will be discussed later, similar studies (Fowlie, 1999) have captured the role of AFS through fluctuations of the business cycle using 'progressive taxation' and 'unemployment benefits'. Unemployment benefits as well as social grants are considered to be automatic fiscal stabilisers since they are intended to respond to any fluctuation in the business cycle, often without being activated by specific discretionary policies. For example, during a recession, unemployment benefits are expected to rise to partially compensate for the decrease in household income.

In an African context, donor funding could also be regarded as an AFS. In many instances, requests for donor funding increase during the downturn phases of the business cycle and decline during economic upturns. Analysing the effects of AFS on output stabilisation requires prior understanding of the functioning of the country's business cycle and the responsiveness of its fiscal policies to shocks. The Medium Term Expenditure Framework (MTEF) provides some insight into government expectations regarding the South African business cycle.

A debate has arisen around the real contribution of AFS in assuaging fiscal policy inflexibility compared to discretionary fiscal policy (Swanepoel and Schoeman, 2003). Automatic stabilisers seem to have the advantage of being more flexible and much more responsive to sudden changes in the business cycle. The European Central Bank has extensively published on the role that AFS plays in strengthening and enhancing confidence during business cycle disturbances. The smoothing role of AFS can be described through a moderation of the exaggerated rise in some macroeconomic variables during an economic upturn (boom phase) and the tempering of the decrease of economic activity during downturns (recession).

The different types of AFS that exist can be determined through the domains in which they affect the economy. Tax-based AFS entail stabilisation through the tax structures. The principle is a simple one: tax collection increases during upturns together with a decrease in social grants while it declines during the downturns with an increase in social grants that stabilises income. The ability of AFS to smooth the business cycle has been used extensively as an indicator to measure the level of disturbances that affect a country's economy (Barrell et al., 2002).

The OECD has developed several analytical frameworks to measure the size and magnitude of AFS as well as the sensitivity of AFS to shocks across countries (OECD, 1999). The behaviour of macroeconomic variables, such as imports, consumer spending, financial markets, exchange rates, international price competitiveness, variations in labour productivity, etc., have all been included to explain the impact of AFS to smooth the business cycle (ibid). The frameworks also acknowledge the temptation to use surplus revenue during upswings although AFS tends to operate more efficiently during downswings. OECD studies also confirm that tax-based stabilisers, such as the current tax on income and wealth (CTIWH), seem to be more efficient regarding output stabilisation. Partly based on the effectiveness of AFS, the European Union developed a stability and growth pact (SGP) for the better coordination of economic policy with stricter control on governments with regard to discretionary policies and restrictions imposed on government deficits (Barrell et al., 2002). Policies largely rely on the outputs from the NiGEM model[1] for use in for their economic planning.

[1]NiGEM is a quarterly macroeconomic model used by the National Institute of Economic and Social Research in

Melitz et al. (1997) states that AFS may not reflect the full picture of fiscal behaviour over the business cycle and political, as well as bureaucratic factors could be more important in explaining fiscal behaviour. Du Plessis and Boshoff (2007) refer to the possibility that weak automatic stabilisers and poor discretionary fiscal policy may have contributed to pro-cyclical fiscal policy in South Africa which actually exacerbated economic fluctuations. However, this paper does not attempt to compare the use of AFS with discretionary fiscal policy, neither does it attempt to propagate specific AFS outcomes through, for example, the introduction of more strict 'fiscal rules' such as tax/GDP ratios, etc., that could be used to improve on the role of AFS. As indicated at the beginning, this is merely an attempt to quantify AFS given the fiscal policy stance over the period 1991-2005.

2 Methodology and Data

The procedure followed in this paper starts by testing for the presence of automatic fiscal stabilisers in South Africa using a structural VAR with testing for cointegration between the output gap (YGAP) and government net lending (GNL) as a share of GDP. The use of 'government net lending' as the dependant variable is justifiable. Government net lending/borrowing, as the balancing tool of the government, equals the difference between total revenue and total expenditure. Concomitantly, net lending/borrowing of the government includes capital expenditure (i.e. gross fixed capital formation) (OECD, 2007). Government revenue mainly constitutes tax revenue, property income, dividends and social contributions while government expenditures mainly consist of social benefits (unemployment benefits, social grants, etc), wages and salaries, interest on the public debt, subsidies and gross fixed capital formation. A negative balance implicates a government deficit which is sensitive to business cycle fluctuations and therefore to output (gap) fluctuations. Thus, when there is cointegration between government net lending/borrowing and output gap fluctuations, it is most likely that the automatic fiscal stabilisers are well functioning.

An exponential smoothing filter is then used to compute different gaps that capture fluctuations in explanatory variables such as 1) the gap on current tax on income and wealth (the revenue side automatic stabilisers); 2) the gap regarding social benefits and grants (expenditure side automatic stabilisers); and 3) the compensation of employees (explaining the gap at industry level). In order to obtain efficiency scores, the gaps are run as inputs against the inverse of the GDP gap using 'Frontier Analyst' for a DEA window analysis. Using the scores obtained, structural VAR models have been constructed to estimate the level of impact that variables, such as a corruption perception index, a conversion factor (openness) and the level of democracy have on the scores. Thus, we test to establish the extent to which these variables strengthen the effects of stabilisers in the economy. The scores depict how effective these automatic stabilisers are (both revenue and expenditure) in reducing output fluctuations, assuming that the deviations in explanatory variables used are mainly caused by the automatic stabilisation process. In this research, an exponential smoothing filter is used to reduce these effects while unemployment benefits have not been included due to the relatively short time series available. Instead, the series 'total socio-economic expenditures' is used as a proxy for automatic stabilisation on the expenditure side with real values to remove the inflationary effects.

The DEA method originates from the Farrell framework (1957) used to measure productive efficiency. Charnes, Cooper and Rhodes (1978) improved the model to include 'measure efficiency' of a variety of decision-making units (DMU). Charnes et al. (1978) describes DEA as a reliable methodology for data adjusting with the main purpose to improve public policy analysis. DEA seems to be the preferred method for efficiency analysis in the non-profit sectors with multiple output production structures where input and output price data are difficult to obtain. A more technical description of the DEA method uses sub-vectors and DEA can be described as a methodology that solves sub-vector equations with output sub-vectors on the one side and input sub-vectors on the other side. The underlying principle is that a DMU's efficiency is measured in comparison with

the United Kingdom. It uses a New Keynesian framework with forward looking agents (Barrel and Hurst, 2003).

other DMUs in the industry or sector, assuming that all firms are either on the efficiency frontier (100%) or below. Thus, DEA window analysis is a useful technique to capture efficiency over time and to create a time series that can be used in regression analysis providing much larger degrees of freedom.

Although the fractional problem could be described through a dual formulation, this paper only considers the primal side of the problem, namely minimising inputs to produce the same level of outputs. Output is defined as the 'inverse output gap' and inputs consist of the gaps in social grants, social benefits and current tax on income and wealth. Applying the concepts of DEA window analysis, the efficiency of decision units over a time period is analysed as it evolves. The weights are determined upon a restriction. Weights are used to reduce both the multiple inputs and/or multiple outputs into a unique input or output combination.

The danger of using a DEA with only cross sections is that it does not account for structural breaks. Once the information considered is recorded including structural breaks, the analysis could be biased and the results unreliable to policy makers. Thus, this model rather uses variable returns to scale (Banker, Charness & Cooper, 1984) with the obtained technical efficiency scores linked to the returns to scale (scale efficiency) of the unit.

Using DEA, the problem is formulated as follows (Kibambe & Koch, 2005):

$$Max h_o = \frac{[\sum_{r=1}^{s} U_r O_{ro}]}{[\sum_{i=1}^{m} V_i N_{io}]} \tag{1}$$

$$subject \quad = \quad to : \frac{[\sum_{r=1}^{s} U_r O_{rj}]}{[\sum_{i=1}^{m} V_i N_{ij}]} \leq 1 \quad \begin{array}{l} j = 1, \ldots, n \\ i = 1, \ldots, m \end{array} \tag{2}$$

with: - O_{ro} and N_{io}: weighted outputs and inputs of the measured DMU;

- U_r; V_i ≥ 0, the variable weights;
- h_o : relative efficiency ratio of DMU.

The efficiency of any of the DMUs is then compared to that of another DMUs' relative efficiency. Once the required weights for $V_i^*$and U_r^* have been established and one of the above equations solved, it becomes possible to determine if $h_o^* \prec 1$.

If $h^* = 1$ then efficiency prevails

In our analysis, the lack of consistent data posed considerable restrictions and we could only include 14 DMUs. This explains why 6 units have achieved scores of 100 percent. The usefulness of efficiency scores relies largely on very basic and iterative ratio analysis. The higher the ratio obtained, the more efficient the related unit is. The efficiency of units is calculated as a function of the best performing unit (100 percent). Thus, efficiency scores are calculated simply as the ratio of its distance from the origin compared to the distance from the origin to the frontier envelope.

Both controlled and uncontrolled inputs are used in the analysis. The use of the 'inverse output gap' rather than the traditional 'output gap' is justified by the fact that DEA strictly prohibits an inverse relationship between inputs and the output level. DEA has the advantage of allowing data to contain zero values provided that there is a minimum of one non-zero input and one non-zero output per unit. Gaps from the trend have been assumed to capture deviations (positive or negative) and are considered as absolute values in order to avoid negatives.

The use of weights is required to control efficiency scores. It forces the programme to consider all inputs. Weights had to be imposed considering the underlying theory. A minimum weight of 10 percent has been imposed on non tax-based AFS in the model. Tax-based AFS do not carry any weighting since their efficiency impact could be derived more easily based on economic theory.

Thus, although the software programme used predetermined weights based on an iterative process, weights imposed from pure theory carry a higher priority. Data was obtained from the International Financial Statistics data base (IFS) and the South African Reserve Bank (SARB).

Table 1 depicts fluctuations in the South African GDP in comparison to changes in revenue collected and socio-economic grants paid (as represented by total expenditures due to a lack of reliable data on grants such as unemployment benefits, etc.).

[Table 1 about here]

Referring to Table 1, a first approximation shows that automatic stabilisation in South Africa seems to be mostly expenditure driven; on average, expenditure elasticities are much higher than revenue elasticities. In fact, with expenditures directly linked to social benefit payments one would *a priori* expect the latter to be a strong automatic stabiliser.

3 Results

3.1 The output gap and efficiency scores

As explained earlier, use is made of the Johansen technique to mainly test for the number of cointegrating vectors while utilising the Holt-Winters smoothing techniques to calculate the output gap.

The AFS effects are assumed to be non-discretionary based simply on the lack of more appropriate series, such as unemployment benefits which would have been much more appropriate in terms of automatic stabilisation. Any deviation from the trend is therefore regarded as an unplanned response, provided that no major shift in policy is recorded. For each of the selected variables (current tax on income and wealth (CTIWH), social benefits (SB), and social grants (SG)), smoothed trends were obtained using the Holt Winter filter. Figures 1 and 2 indicate that as expected, CTIWH, SB, and SG, present large deviations from the trend each illustrating some form of automatic stabilising action.

[Figures 1 and 2, about here]

The model used to compute the scores in Table 2 has been set on a BCC mode (varying mode) seeking to maximise output (the inverse of the output gap) given current inputs. A standard tolerance is applied as the data set is smaller than 2500. It is a single output multiple inputs model with one controlled output (inverse Ygap) and three controlled inputs (SGgap, CTIWHgap, and SBgap). The efficiency scores have been transformed into a time series used as the dependent variable in the Johansen estimates to test whether any variables, such as corruption, openness, etc., have a significant effect in strengthening AFS in the South African economy. The threshold of 50 percent is used to distinguish between DMUs in terms of the scores obtained. Scale values are also included in the table.

[Table 2, about here]

3.2 Cointegrating evidence of efficiency scores

Table 3 shows that at least one (and at most two) cointegrating vectors could be specified depending on the trend specification of the function. Openness indeed enhances the effect of AFS on output. The underpinning explanation being that openness contributes to economic growth which in fact expands the revenue base and results in increased levels of socio-economic expenditure. Table 4 presents the Johansen estimates with signs and magnitudes of the regression 'scores' and 'openness' with normalisation for one cointegrating equation. Estimates indicate a strong and positive relationship between 'openness' and 'efficiency scores'. It is therefore expected that a larger level of openness strengthens the influence of AFS on output fluctuations.

[Table 3 and 4 about here]

In order to observe a possible relationship between efficiency scores and the level of flexibility in the country's conversion factor (exports), we tested for cointegrating vectors. Finding such cointegrating vectors proved to be difficult except in the case of a quadratic trend specification. Thus, it should be cautioned that results have to be interpreted with care before relating it to strong policy considerations (see Table 5).

[Table 5, about here]

Since corruption is often used as an indicator of the level of good governance and a country's ability to attract foreign direct investment (FDI), it has been incorporated into our analysis. Table 6 presents evidence that supports the presence of cointegration between CPI and efficiency scores. Data reflecting a corruption perception index were obtained from an unpublished external source where the countries are classified on a scale from 1-10. The larger the index, the less corruption is likely to be found in that country. This index is compiled based on surveys conducted among business agents (Transparency International, 2007). It should therefore be noted that the index mostly reflects corruption at corporate levels. Estimates support the view that the less corrupt a country is, the more active automatic stabilisation will be (see the positive and significant coefficient of CPI in the regression in Table 7).

[Tables 6 & 7, about here]

4 Conclusion

A four-step analysis was used to identify the presence and impact of automatic stabilisers in the South African economy. These steps included 1) measuring the size of AFS using exponential smoothing filters; 2) computing efficiency scores on AFS; 3) identifying key determinants of AFS efficiency scores in the South African economy using a VAR; and 4) identifying cointegrating relationships between the scores and these determinants.

A broad conclusion to be derived from this paper is that AFS is active in stabilising output although their capacity to respond to business cycle fluctuations depends on the level of distortions existing in the economy and on the duration of shocks.

Higher levels of economic growth and a concomitant increase in socio-economic welfare can only be possible within a stable economic environment. Accumulating debt limits fiscal manoeuvrability in terms of its capacity to react appropriately to macroeconomic fluctuations. Thus, automatic fiscal stabilisers could make an important contribution towards economic stabilisation in an environment where governments find it particularly difficult to correctly time fiscal interventions to address volatility in the economy.

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APPENDIX

Table 1: Revenue and Expenditure Elasticities

Period	Total Revenue	GDP	Revenue Elasticities	Gross domestic expenditure	Expenditure Elasticities
1970	20.63	5.25	0.25448376	10.16	0.516732283
1971	9.35	4.28	0.45775401	7.11	0.601969058
1972	19.43	1.65	0.08492023	-4.69	-0.351812367
1973	16.87	4.57	0.27089508	11.57	0.394987035
1974	31.54	6.11	0.19372226	15.24	0.400918635
1975	19.2	1.7	0.08854167	0.71	2.394366197
1976	14.96	2.25	0.15040107	-2.92	-0.770547945
1977	15.63	-0.09	-0.0057582	-6.34	0.014195584
1978	12.81	3.01	0.23497268	1.99	1.512562814
1979	17.49	3.79	0.21669525	3.08	1.230519481
1980	20.81	6.62	0.31811629	12.85	0.515175097
1981	35.55	5.36	0.15077356	11.46	0.467713787
1982	9.15	-0.38	-0.0415301	-5.71	0.066549912
1983	19.75	-1.85	-0.0936709	-5.61	0.329768271
1984	10.91	5.1	0.46746104	9.07	0.562293275
1985	22.81	-1.21	-0.0530469	-7.76	0.155927835
1986	26.4	0.02	0.00075758	0.74	0.027027027
1987	12.33	2.1	0.1703163	3.78	0.555555556
1988	15.09	4.2	0.27833002	6.26	0.670926518
1989	27.86	2.39	0.08578607	1.19	2.008403361
1990	26.74	-0.32	-0.0119671	-2.05	0.156097561
1991	10.16	-1.02	-0.1003937	-0.62	1.64516129
1992	7.98	-2.14	-0.2681704	-1.87	1.144385027
1993	6.64	1.23	0.18524096	1.6	0.76875
1994	16.9	3.23	0.19112426	5.31	0.608286252
1995	15.38	3.12	0.20286086	4.27	0.730679157
1996	13.7	4.31	0.31459854	4.13	1.043583535
1997	14.86	2.65	0.17833109	2.56	1.03515625
1998	12.28	0.52	0.04234528	-0.14	-3.714285714
1999	11.74	2.36	0.20102215	-0.28	-8.428571429
2000	8.37	4.15	0.4958184	3.31	1.253776435
2001	8.61	2.74	0.31823461	2.37	1.156118143
2002	15.08	3.56	0.23607427	4.76	0.74789916
2003	12.41	2.81	0.2264303	5.26	0.534220532
2004	7.17	3.71	0.51743375	6.29	0.589825119

Note: Elasticities were calculated using the formula:

$$\frac{\Delta GDP}{\Delta INCOME} \quad and \quad \frac{\Delta GDP}{\Delta EXPENDITURE}$$

Table 2: Efficiency scores over time (years are considered to be the DMUs)

Units	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05
Scores	>50	>50	<50	<50	>50	<50	>50	>50	<50	<50	<50	>50	<50	<50	
Scale	crs	crs	drs	drs	crs	drs	crs	crs	drs	drs	drs	crs	drs	irs	drs

Note:

1) *Drs: Decreasing returns to scale;*
2) *Irs: Increasing returns to scale;*
3) *Crs: Constant returns to scale.*

Table 3: Test for number of cointegrating vectors (Scores and Openness)

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	1	1	2	1	2
Max-Eig	1	1	2	1	2

Selected (0.05 level) Number of Cointegrating Relations by Model*

Table 4: Johansen estimates (Normalised equation)

SCORES	OPEN	Prob. (unrestricted Trace)	Prob. (unrestricted Maximum Eigenvalue)
1.000000	2480.211	0.0000	0.0002
	(0.00012)	0.0039	0.00039

Note: Adjusted standard error in parentheses.

Table 5: Number of cointegrating vectors (Scores and Conversion Factor)

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	0	0	0	0	2
Max-Eig	0	0	0	0	2

Table 6: Number of cointegrating vectors (Scores and CPI)

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	2	1	2	0	0
Max-Eig	2	1	2	0	0

Table 7: Johansen estimates

SCORES	CPI	Prob. (unrestricted Trace)	Prob. (unrestricted Maximum Eigenvalue)
1.000000	14.52117	0.0219	0.1037
	(0.00442)	0.0723	0.0723

N.B.: Adjusted standard error in parentheses.

Figure 1: SB vs SBSM

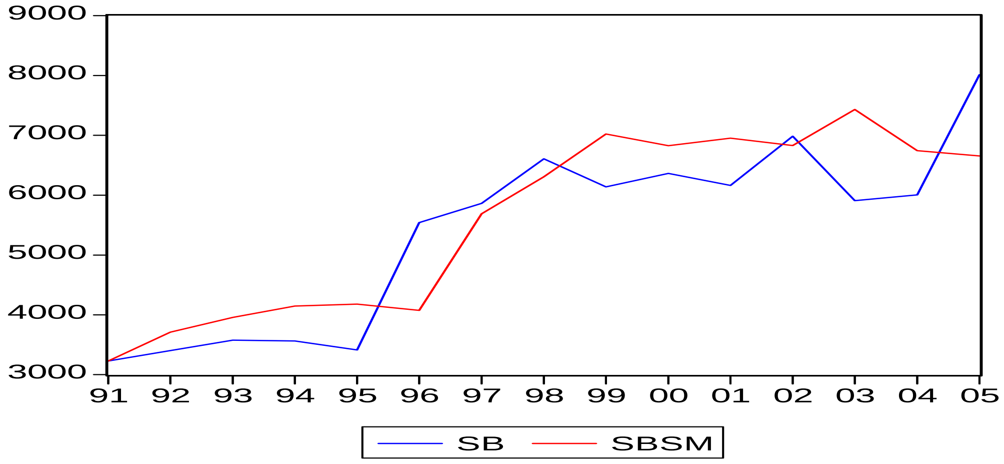

Figure 2*:* SG vs SGSM