Differential Electricity Pricing and Energy Efficiency in South Africa

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Abstract

By international standards the economy of South Africa is extremely energy intensive with only a few countries having higher intensities. SA's primary energy use per unit of GDP is amongst the highest in the world The high energy and electricity intensity of the economy partly reflects SA's resource endowments (in particular the abundance of coal) but is also a function of the historical under-pricing of coal and electricity by the authorities South African mining & industrial electricity efficiency is particularly concerning and considerably lower than the global average. This paper sets out to fill a significant gap in the South African energy literature by highlighting the importance of incorporating electricity demand factors as part of the country's energy policy and electricity planning horizon. The paper focuses its attention on modeling the electricity consumption of SA's industrial and mining sectors given these account for the lion's share of electricity demand. A differential electricity pricing policy which targets electricity intensive industrial and mining activities (as practiced in China since 2004) is viewed by the author to be a superior policy to blanket electricity price increases administered by authorities in an effort to encourage electricity savings and improve energy efficiency in South Africa.

Keywords: Electricity consumption, industrial, South Africa

JEL codes: Q41, C23

1 Introduction

By international standards the economy of South African is extremely energy intensive with just a handful of countries notably Iceland, Russia and China having higher intensities. South Africa's primary energy use per unit of GDP is amongst the highest in the world standing at 0.13 tonnes of oil equivalent (toe) per thousand 2005 US dollars of GDP in 2010 calculated using purchasing

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power parities This compares with values of other energy intensive economies like Iceland (0.25), Russia (0.22) and China (0.16) and averages of 0.09 and 0.15 respectively for OECD and non-OECD countries According to energy statistics published by the IEA (2012) there has been a reduction in South Africa's energy use per unit of GDP in recent years but this compares unfavourably with larger average reductions for both OECD and non-OECD countries.

The high energy intensity (and in the case of this paper specifically the electricity intensity) of the economy partly reflects South Africa's natural resource endowments in particular the local abundance of coal and other mineral resources but is also a function of the domestic under-pricing of coal and electricity by the authorities for a long period of time. Historically, the country has followed a heavily capital and electricity-intensive development trajectory largely based on the use of coal. In 1991, Eskom (the national electricity provider) proposed a price agreement with government to reduce the real price of electricity to benefit electricity-intensive activities within South Africa and place them in a stronger position to compete on international markets.

Given the country's history of low and stable electricity prices, South African electricity efficiency is substantially lower on average than in other countries and improvements to date have been small by international standards. Although under-emphasised in the Integrated Resource Plan (IRP) which sets out South Africa's plan for electricity generation over the next 20 years, one of the main triggers (identified by market commentators) to encourage improvements in South Africa's electricity efficiency is to allow energy prices to rise to fully cover operating and capital costs and to properly value electricity production, transmission and distribution externalities. Related research by Lam (2001) in the case of China has indicated that artificially low electricity tariff's need to be replaced by a system that better reflects the capital costs of power generation and transmission in order to encourage local & foreign investment and efficiency improvements in power generating capacity. This paper sets out to fill a significant gap in the South African energy literature by highlighting, as in research conducted in the case of China and reported by Wang et al (2010), the importance of incorporating electricity demand factors as part of South Africa's energy policy and electricity planning horizon. The paper focuses its attention on modeling electricity consumption for South Africa's industrial and mining sectors given these two sectors account for the lion's share of the country's electricity demand. Our research sets out to support claims by Inglesi-Lotz & Pouris (2012) that differentiated electricity price policies are required if South Africa is to create an effective energy efficiency policy. Finally, our study estimates long-run output and price elasticities of electricity demand for the various South African industrial sub-sectors similar to research by Inglesi-Lotz & Blignaut (2011b). It does so however by employing different econometric techniques and by analysing a longer and more recent time period: 1989-2009 in an attempt to establish which sectors would be the best target candidates of a proposed differential electricitypricing scheme A differential electricity pricing policy (as that practiced in China since 2004) and critically reviewed in by Lin & Liu (2010) is viewed by the author to be a superior policy to blanket electricity price increases administered by authorities in an effort to encourage electricity savings and improve energy efficiency in South Africa.

The remainder of the paper is set out as follows. Section 2 provides a review of the relevant energy efficiency and energy demand literature whilst section 3 sets out the empirical methodology and data employed in the current study. Section 4 reports the econometric results of South African industrial electricity consumption. Section 5 briefly presents international experiences with industrial energy efficiency policies, section 6 sets out our conclusions and policy recommendations.

2 Background

2.1 Electricity efficiency and intensity

Energy efficiency according to the International Energy Agency (IEA) and the World Energy Council (WEC) involves a reduction in the energy input of a given service (such as heating/ cooling, etc.) or level of economic activity. The resulting reduction in energy consumption whilst usually associated with technological changes can also come about as a result of better organisation and management or improved economic conditions in the sector under investigation. Electricity efficiency which is the focus of this research paper is measured as the change recorded in electricity intensity in order to account for its quantitative nature. A common definition of electricity intensity adopted in studies by Sun and Ang (2000), Mukherjee (2008) and Inglesi-Lotz & Blignaut (2011a) measures this intensity in terms of electricity consumption per national production unit such as the joule (J) per US$ of GDP. In this paper we follow this approach and measure the electricity intensity of industrial sectors as the electricity consumption to output contribution of that sector. Improving the electricity efficiency of production processes is generally regarded as a low cost and effective way of curbing energy demand in an economy.

2.2 Electricity intensity: The South African case

Energy statistics published by the IEA (2012) indicate that South Africa's electricity intensity has been rising at an alarming rate and by 2010 stood at 0.451 GWh per 2005 US million dollars comparable to values for China (0.371), Russia (0.362) and far in excess of the OECD and non-OECD average ranges of 0.249-0253 and 0.196-0277 over the review period 1971 to 2010 respectively (see Table 1 for details).

The high overall electricity intensity of the South African economy when compared internationally is the result of a heavily capital and electricity-intensive development path that has been driven by the extraction of resources and a set of inter-connected economic activities termed the 'Minerals-Energy Complex' (Fine & Rustomjee, 1996). This Complex is primarily based on mining, and limited mineral beneficiation that is underpinned by the provision of cheap electricity Eskom (the national electricity provider) has been of fundamental significance to the Minerals-Energy Complex through its electricity price fixing agreement with government This agreement has reduced the real price of electricity since the early 1990s to benefit electricity-intensive activities within the economy. South Africa has thus enjoyed electricity prices amongst the lowest in the world and although prices started rising sharply in 2008 after a series of power outages by 2011 South Africa still had extremely low electricity tariffs compared to other countries (see figure 1). Whilst statistics for China are not included in this figure, it is noted that the fare charged by the State Grid for 2010 stood at 0.16 yuan (US$26) per GWh) Eskom estimates that current South African electricity prices are still only about two thirds of the level needed to cover total costs, even though average prices have more than doubled in real terms since 2007 (see figure 2).

The alarming rate of increase in South Africa's electricity-intensity for the period 1971-2010 implies that South African economy wide electricity efficiency compares poorly internationally (for details on this refer back to the percentage changes indicated in Table 1). Winkler & Marquard (2009) suggest that South African industrial electricity efficiency is particularly concerning and considerably lower than global averages. In particular, industrial activities linked to the Minerals-Energy Complex account for most of the country's electricity consumption whilst contributing far less to South Africa's GDP. According to the SA Department of Energy, industry and mining consumed 54% of the electricity produced in the country in 2010 which has only slightly changed from the 66% consumed in 1989 (see Table 2).

Our estimates of South Africa's industrial electricity intensity for the period 1989-2010 are presented in Table 3. Related research by Inglesi-Lotz & Blignaut (2011a) found South Africa's primary minerals extraction and processing industries linked to the 'Minerals Energy Complex' to be extremely electricity-intensive by OECD standards.

Whilst the reported estimates in themselves do not prove that South African industry is inefficient it does suggest that large quantities of electricity are used (per unit value produced) in the country's industrial processes. Information on electricity intensity/efficiency is essential to energy policymakers in understanding how a country's demand for electricity changes when the economy undergoes changes in its economic structure. This takes on added significance in a country facing critical energy supply constraints as has been the case in South Africa since the major electricity blackouts of 2008

Although now relatively dated, the 1998 White Paper (DME 1998) forms the back-bone for all energy related policy in South Africa. In terms of the energy efficiency of South Africa's industrial and commercial sectors, the White Paper, commits government to the following:

Promotion of energy-efficiency awareness;

Encouragement of the use of energy-efficiency practices;

Establishment of energy-efficiency standards for commercial buildings; and

Monitoring the progress

In 2005 the Department of Minerals and Energy released South Africa's first Energy Efficiency Strategy (DME 2005). A national target of 12% for electricity efficiency improvement by 2015 was set by the strategy. The aim of the Strategy was to set a policy framework allowing for affordable energy to all whilst at the same time diminishing the negative environmental consequences of the extensive energy use in the country. As reported by Sebitosi (2008) whilst South Africa's electricity efficiency target was set in light of the fact that the country was the seventh biggest emitter of greenhouse gases on a per capita basis and the national electricity intensity was almost twice the average of the OECD countries, the country's Energy Efficiency Strategy has had limited impact to date Follow up research by Inglesi-Lotz & Pouris (2012) which focused on factors affecting trends in energy efficiency in South Africa from 1993 to 2006 indicated that structural changes of the economy have played a significant role in the increasing economy-wide energy inefficiency. This according to the authors contrasts with the utilisation efficiency of South Africa's energy intensity which has contributed to positive improvements in the country's energy efficiency.

The research by Inglesi-Lotz & Pouris (2012) highlights the urgent need for electricity efficiency improvements in South African industry in light of the sector's large percentage consumption of total electricity produced According to Fawkes (2005) electricity efficiency improvements present an opportunity for South Africa firms to: increase profit; improve environmental compliance; mitigate to some extent competition from rival producers; and help overcome capital investment constraints. Electricity efficiency improvements should as such be embraced by the country's industrial producers.

It is crucial for an economy to be able to generate and distribute a sufficient supply of electricity if sustainable economic growth is to be achieved in that the availability of energy resources and the reliability of these inputs are important determinants of industrial productivity. At present, there is no feasible method to store electrical power on a country-wide scale. The installed capacity must, therefore, be able to generate enough electricity to meet peak demand (Edwards, 2012). Growth in capacity to generate power must keep up with growth in demand from consumers in order to avoid economically damaging blackouts or brownouts. Power shortages hinder growth not only by decreasing productivity, but by forcing firms to re-optimise among factors by using more material, and fewer energy inputs (Fisher-Vanden et al, 2013). Firms will tend to produce fewer (and possibly import more) of the inputs required in the production of their final output. If blackouts become too frequent, firms may even resort to generating their own energy inputs. In the case of China's electricity supply shortages of the early 2000s, Fisher-Vanden et al (2013) found that the overall effect of the power shortages was to increase companies production costs, finding no evidence of an increase in self-generation by firms.

2.3 Balancing South Africa's electricity supply and demand

The price industrial consumers pay for electricity in South Africa is determined by regulators, and not demand-supply forces in the market. The lack of an equilibrating price mechanism can lead to temporary demand-supply imbalances, especially if government is slow to react to market signals. In a situation where the price of electricity is driven by supply and demand, a high price would signal excess demand and would soon drive more investment into the industry. High electricity prices also encourage innovation in alternative methods of power generation, as well as greater efficiency in consumption and in production processes in which electricity is a key input (Edwards, 2012). Without a market-determined electricity price it is up to regulators to forecast the future energy needs of the economy and make the appropriate capacity investments.

The electricity supply problem faced by South Africa can be thought of in terms of two related dimensions. Total installed generation capacity was insufficient during 2007/2008, and is currently still struggling to meet peak demand. The subsequent scheduled blackouts, termed 'load shedding', had highly adverse effects on economic growth, job creation, and foreign and local investor confidence. At present, the safety margin between supply capacity and demand is too low to allow the required routine maintenance of capacity, leaving the state electricity utility vulnerable to unexpected demand increases and down time (HSRC, 2009). Both facets of the problem are caused by inadequate generation capacity and a lack of quality coal inputs. Unable to finance the required capacity expansion through profits, Eskom was forced to source a 'controversial' World Bank loan to fund the construction of the Medupi coal-fired power station and other smaller projects (Greenpeace, 2012). Through its Eskom Power Investment Support project, the World Bank will contribute a total of US$3.75 billion to the expansion, of which US$3.05 billion will go towards the 4.8GW Medupi power station, US$260 million towards a 100MW wind and 100MW concentrated solar power project, and US$485 towards efficiency improvements including the conversion of coal transportation from road to rail (World Bank 2012).

The scope of supply-side solutions to the problem is limited in the short-run, primarily due to the long lead times associated with power station construction. Demand side solutions where users are induced to decrease electricity demand are, therefore, more useful in emergency situations where a rapid reduction in consumption is needed. Incentives put in place to curb demand could include government subsidies for installing less electricity-intensive production equipment, or a tariff structure that encourages users to conserve electricity where possible (HSRC, 2008).

Cheap electricity has placed electricity-intensive South African industries in a strong position in international markets, which has encouraged investment in these industries. Regulators are now reluctant to raise tariffs for fear of eroding the competitiveness of these firms and precipitating widespread job cuts. Eskom has also entered into a 25 year pricing contract with Alusaf, a subsidiary of BHP Billiton and South Africa's primary aluminium producer, which guarantees a constant supply of electricity at a reduced tariff that is linked to the London Metal Exchange aluminium price. Eskom's Special Pricing Agreements (SPA) have required subsidisation from residential users in the form of both higher residential tariffs and less reliable access to electricity. The present pricing regime is, therefore, transferring wealth from residential users to energy-intensive big business, in contrast to government policy that specifies that large-scale industrial users are to cross-subsidise poor domestic consumers (Greenpeace 2012).

Blignaut & Inglesi-Lotz (2011b) note that the steady decline in real electricity prices between the 1980s and 2007 led to a lower electricity consumption responsiveness to changes in the electricity price. On the other hand, the early 1980s saw a sharp rise in the real price of electricity and a subsequent increase in magnitude of the price elasticity of electricity consumption. Electricity tariffs have been rising rapidly since 2007, providing an opportunity for the sensitivity of demand to the changing electricity price to be observed. Real GDP was 10.4% higher in the first half of 2012 than it was in 2007, while the real electricity price had more than doubled over the period. Electricity output had fallen by 2.6%, partly as a result of the rapid tariff increase and partly due to sectoral shifts that are unrelated to changes in the electricity price (OECD, 2013). The fixed nature of many structures and pieces of equipment used in electricity-intensive production processes generally leads to the belief that demand elasticities are low in the short-run. In the long-run, the variability of these factors allows a greater degree of optimisation in production processes and substitution of inputs, leading to higher demand elasticities. A sharp rise in the real price of electricity over the next decade is likely to amplify the role that electricity tariffs play as a demand determinant in the South African economy which is why accurate estimates of industrial electricity demand responsiveness to output and price changes are crucial in the South African context.

The econometric estimation of energy demand elasticities can be traced back in time to a period substantially earlier than the seminal work of Kraft and Kraft (1978) which sparked renewed interest in energy-growth studies. Despite the importance of reliable elasticity estimates in energy modelling to inform economic policy there is a surprising scarcity of literature on industrial energy demand elasticities particularly so in the case of electricity. Table 4 provides a summary of industrial electricity demand studies to date.

The studies differ largely with respect to the econometric methodology used, the time span covered, and the country analysed. In terms of the elasticity of industrial electricity demand to economic activity this is indicated to vary between 0.15 and 1.22 whilst the elasticity with respect to price is indicated to vary between -0.04 and -0.45 in the short-run and -0.31 and -1.94 in the long-run.

3 Methodology and data

In order to estimate a long-run relationship for the South African economy's industrial sectors' electricity demand we employ the following general function specification:

$$E_t = f(Q_t, P_t, Z_t, X_t) \tag{1}$$

where electricity consumption (E_t) is contemporaneously dependent on the level of real economic activity (Q_t), real electricity price (P_t), other endogenous variables (Z_t) such as the real price of a substitute for electricity, and exogenous variables (X_t), such as a sector-specific coefficient for autonomous technical change, energysaving technological progress or changes in the structure of industrial production. Such structural changes may be due to the substitution of labour by electricity-using capital and/or the offshoring of labour intensive production processes to other countries. Changes such as these tend to increase the electricity intensity of industrial sub-sectors in contrast to energy-saving technological progress Since these factors affect the relationship between the other variables we can account for these indirectly through the inclusion of a deterministic term.

Numerous studies (for an up to date survey of these see Stern, 2012) find that electricity in industrial processes is not easily substituted by other energy inputs. Taking cognisance of this in our analysis we do not control for inter-fuel substitution and thus exclude the prices of other energy carriers. We therefore, adopt the following standard constant elasticity (Cobb-Douglas type) representation in our empirical analysis:

$$E_t = C_0 exp(dummy) Q_t^{\beta q} P_t^{\beta p} \tag{2}$$

where $Xt = Cexp(dummy)$ is the deterministic term, C is a constant, $exp(dummy)$ is a time dependent dummy and βq and βp are the demand elasticities in respect of economic activity and electricity price, respectively. The advantage of this standard log-linear specification is its simplicity and limited data requirements and according to Pesaran *et al.* (1998) performs better than more complex models.

Econometric studies on the estimation of energy demand elasticities are often based on time series data. Since the seminal work of Engle and Granger (1987), cointegration analysis has increasingly become the favoured methodological approach for analysing time series data to overcome the spurious regression problem when the time series are integrated of order one, I(1) or higher. Instead of taking first differences of the data, the common methodological approach adopted previously, it is possible to deal with the problem by identifying existing stationary linear combinations of two or more non-stationary time series. The presence of stationary linear combinations indicates common stochastic trends (i.e. cointegration), these are interpreted as long run equilibrium relationships between the variables and, can therefore, according to Engle and Granger (1987), be characterised by being generated through an error correction mechanism.

Unfortunately, unit root and cointegration testing undertaken in a pure time series context suffers from the problem of low predictive power and small sample size. The inclusion of a cross-sectional dimension in the analysis is often employed to help overcome this problem. An alternative approach is the autoregressive distributed lag (ARDL) bounds testing approach to cointegration. This method, introduced by Pesaran and Shin (1999) and Pesaran *et al.* (2001), has enjoyed considerable support over recent years. The advantage of the ARDL approach is that information regarding the order of integration of the variables is not required. The pretesting for unit roots, which is needed in other cointegration methodologies can be omitted. The significance of a long-run relationship is tested using critical value bounds, which are determined by the two extreme cases that all variables are I(0) (the lower bound) and that all variables are I(1) (the upper bound).

Taking natural logarithms of Eq. (2) and adding an error term yields the econometric specification of our long-run industrial electricity demand function:

$$e_t = \beta + \beta_1 dummy + \beta_2 q_t + \beta_3 p_t + \varepsilon_t \tag{3}$$

where $e_t = \ln(Et)$; qt= $\ln(Qt)$ and $pt = \ln(Pt)$. The βs are the long-run coefficients and ε_t is a white noise error term.

The first step of the bounds testing approach is to estimate the following unrestricted error correction model using OLS:

$$\begin{aligned} \Delta e_t &= c + dummy + \phi_1 e_{t-1} + \phi_2 q_{t-1} + \phi_3 p_{t-1} + \sum\nolimits_{i=1}^{k} \varphi_{1i} \Delta e_{t-i} \\ &\quad + \sum\nolimits_{i=1}^{l} \varphi_{2i} \Delta q_{t-i} + \sum\nolimits_{i=1}^{m} \varphi_{3i} \Delta p_{t-i} + v_t \end{aligned} \tag{4}$$

where the ϕ are the long-run multipliers, $c$is a drift term, φ are the short-run coefficients and vt is a white noise error term. Due to the fact that it is not clear *a priori* whether q and p,are the long-run forcing variables for electricity consumption, current values of Δq and Δp are excluded from Eq. (4).

As a second step, an F-test on the joint hypothesis that the long-run multipliers of the lagged level variables are all equal to zero against the alternative hypothesis that at least one long-run multiplier is non-zero is conducted, i.e.:

$$\begin{aligned} H &: \phi_1 = \phi_2 = \phi_3 = 0; \\ H_1 &: \phi_1 \neq 0, or \phi_2 \neq 0, or \phi_3 \neq 0. \end{aligned}$$

Critical values which depend on the number of regressors and the deterministic terms included are provided by Pesaran and Pesaran (2009). For each conventional significance level, two sets of critical values are given, which constitute the lower and the upper bound. The lower bound represents the critical values for the case in which all included variables are assumed to be I(0), while the upper bound assumes all the variables to be I(1). Hence, all possible combinations of orders of integration for the single variables are covered. If the calculated F-statistic lies above the upper bound, the null hypothesis of no cointegration can be rejected, irrespective of the number of unit roots in the single variables. On the other hand, if it lies below the lower bound, the null hypothesis is not rejected. Only if the F-statistic lies between the bounds, are the results of the inference inconclusive, given that the order of integration of the single variables is unknown.

If the existence of a significant cointegration relationship is identified by the bounds F-test, the next step is to select the optimal ARDL specification of Eq.

(4). This process is guided by the Akaike Information Criterion (AIC) and the Schwarz Bayesian Criterion (SBC). Furthermore, the properties of the residuals are checked to ensure the absence of serial correlation. A representation of the ARDL(klm) model in the general case is:

$$\varDelta e_t = b_0 + \sum\nolimits_{i=1}^{k} \alpha_{1,i} e_{t-i} + \sum\nolimits_{i=0}^{l} \alpha_{2,i} q_{t-i} + \sum\nolimits_{i=0}^{m} \alpha_{3,i} p_{t-i} + \omega_t \tag{5}$$

where ω_t is an error term and k, l and $m$are the lag lengths of the single variables.

The long-run coefficients are constructed as non-linear functions of the parameter estimates of Eq. (5) as follows:

$$\beta = \alpha_c \;/(1 - \sum\nolimits_{i=1}^{k} \alpha_{1,i}) \tag{6}$$

$$\beta_1 = \alpha_d \;/(1 - \sum\nolimits_{i=1}^{k} \alpha_{1,i}) \; and \tag{7}$$

$$\beta_J = \sum\nolimits_{1}^{Z} \alpha_{j,i} \;/(1 - \sum\nolimits_{i=1}^{k} \alpha_{1,i}) \tag{8}$$

with j= 2, 3 and $z = k$, l, m. β and β_1 are the constant and the dummy in the long-run model represented by Eq. (3), respectively. The βj are the long-run slope coefficients.

Finally, the (dynamic) short-run coefficients for the error correction representation are estimated according to:

$$\begin{aligned} \varDelta e_t \quad = \quad & \theta_c + \theta_d + \theta_{ect} ECT_{t-1} + \sum\nolimits_{i=1}^{k} \alpha_{1,i} \varDelta e_{t-i} + \sum\nolimits_{i=1}^{l} \alpha_{2,i} \varDelta q_{t-i} \\ & + \sum\nolimits_{i=1}^{m} \alpha_{3,i} \varDelta p_{t-i} + u_t \end{aligned} \tag{9}$$

where $ECTt_1$ is the error correction term resulting from the estimated long-run equilibrium relationship, Eq. (3), and θ_{ect} is the coefficient reflecting the speed of adjustment to long-run equilibrium, i.e. the percentage annual correction of a deviation from the long-run equilibrium the year before.

Data

South African electricity consumption data at the level of the different economic sub-sectors is taken from the Department of Energy's Energy Balances (DoE various issues) and is measured in MWh. The Energy Balances classify the economy into five sectors: the industrial sector, the commercial, agricultural, residential and transport sectors which are further disaggregated into 22 industries. This data is collected by the Trade and Industry division in Stats SA in collaboration with the DoE. The main source of the information is Eskom and the National Energy Regulator (NERSA)

The data series on electricity prices for the various economic sub-sectors is taken from Eskom's yearly tariff & charges booklet. The tariff & charges booklet identifies time of use (TOU) active energy charges for urban, residential and rural areas. The charges are payable per kWh of electrical energy used and differ for the high-demand (June - August) and low-demand (September - May) seasons. The charges also differ by the time-of-day in peak, standard and off-peak periods. The tariffs applied to the industrial and mining users in the case of this study are the urban miniflex and megaflex rates. Miniflex rates are TOU electricity tariffs for urban customers with a notified maximum demand from 25 kVA up to 5 MVA that are able to shift load. Megaflex rates are TOU electricity tariffs for urban customers with a notified maximum demand greater than 1 MVA that are able to shift load Whilst these prices are presented in nominal terms we convert these into real prices by using the annual Consumer Price Index (CPI), with 2005 as the base year, provided by Statistics South Africa (StatsSA).

The data series on real total output is taken from Quantec's Industry trends database This is measured in millions of Rands and converted into 2005 real prices by using the Consumer Price Index (CPI) from Statistics South Africa (StatsSA)

4 Econometric Results

As a first step of the ARDL bounds testing procedure we estimate Eq.(4) for each industrial sector using OLS. As our analysis is based on annual data, we consider lag lengths of one and two. A time specific dummy which takes into account a structural break in our data series for the 1993/1994 political transition to democracy in South Africa is included whenever significant. Next we undertake a F-test on the joint significance of the lagged variables in levels. The results of the F-tests for all sectors are shown in Table 5. The F-statistic indicates no joint significance for the sectors mining; non-metallic minerals; textiles, leather & footwear; and machinery & equipment. For all other industrial sectors the null hypothesis of no long-run relationship is rejected at least at the 10% level.

Long-run and short-run elasticities

Based on the bounds test results, we proceed to estimate the long-run elasticities and the corresponding error correction models for nine industrial subsectors. Equation (3) is estimated for each of these South African industrial sectors, the model selection is guided by the Schwarz Bayesian Criterion (SBC) which suggests a maximum of two lag lengths be incorporated in our model estimation. The estimated residuals are tested to ensure they are not serially correlated. The parameter estimates are then used to construct the long-run elasticities according to Eqs. (6)–(8). Finally, to establish the short-run dynamics of industrial sector electricity consumption, the corresponding error correction models according to Eq. (9) are estimated using the lagged ECTs obtained from the long-run relationships estimated.

Tables 6 to 8 provide a summary of the estimated long-run coefficients, the error correction estimation results and the diagnostic tests (for serial correlation, normality, and heteroscedasticity) of the underlying ARDL models for the respective industrial sectors. The order of the industrial sector-specific ARDLs along with the estimated long-run coefficients are presented in Table 6. For total industrial electricity consumption the signs of the statistically significant income and price elasticities are positive and negative as expected confirming the results of previous work over the short period of analysis 1993-2006 by Inglesi-Lotz & Blignaut (2011b). Our results suggest a price inelastic electricity demand (elasticity = -0.738) for South Africa's industrial sector for the period 1989-2009. This compares favourably with the price elasticity = -0.869 estimated by Inglesi-Lotz & Blignaut (2011b). Our results in respect of industrial sector output suggest this likewise is a highly significant factor which influences SA's industrial electricity consumption with an output elasticity = 0.511. Inglesi-Lotz (2011b) estimate an elasticity = 0.712 in this regard. In respect of the industrial sector specific results the long-run output elasticities range between 0.253 and 2.239 (in the case of the short-run dynamics between 0.420 and 1.532). The long-run demand elasticities with regard to price range between -0268 and -3.404and in the short-run between -0.8059 and -1.738 The results suggest that significant responsiveness's in industrial electricity consumption to price changes are found to exist in the mining, construction, paper, pulp & print and iron & steel industries.

5 International experience with industrial energy efficiency policies

Previous research by Nilsson (1993) on energy intensity trends in 31 industrial and developing countries over the period 1950-1988 suggests that electricity intensities are likely to develop similarly to how energy intensities have developed as economic structure and end-use efficiency continue to change. According to Levine et al (1995) there is a wealth of experience among industrialised countries with technologies and policies to increase electricity end-use efficiency. The authors indicate that some developing countries are beginning to adopt these technologies and policies many of which focus on the demand-side management of electricity consumption. In the case of the industrial sector of Slovenia, Al-Mansour et al (2003) indicate that improvements to internal industrial conversion systems, notably cogeneration of electricity and heat, are amongst the technologies that produce a major part of the overall electricity efficiency gains. Research by Fleiter et al (2012) on energy efficiency in the German pulp and paper industry identifies heat recovery in paper mills and the use of innovative paper drying technologies as the most influential technologies in reducing the sector's energy demand.

Aided by an extensive discussion of worldwide experiences with the demand-side management of electricity, Wang et al (2009) report on the integral role of China's demand response programs in alleviating and coping with electricity supply shortages at a national level. In addressing South Africa's electricity supply shortages, Inglesi-Lotz & Blignaut (2011a) identify the need for a nationwide demand-side management programme to improve energy efficiency. The authors suggest that electricity price reform, such as that recently announced in South Africa, whereby the electricity price level is increased significantly in conjunction with block-rate tariffs that charge a higher rate to those that consume more is vital if the country is to reduce its electricity intensity. These claims are supported by follow up research by Inglesi-Lotz & Pouris (2012) based on a decomposition analysis of South Africa's energy efficiency that calls for a differentiated energy pricing regime similar to that practiced in China. These claims are in line with earlier research reported in Energy by Siddayao (1983) that highlighted the important role played by energy pricing policy in influencing patterns of energy consumption and production in the U.S. and in the Asia-Pacific region.

The principles, effects and problems associated with a differential energy pricing policy (DEPP) for energy intensive industries in China, is discussed at length by Lin and Liu (2011). In essence, in the case of China, the government instituted special energy pricing policies in June 2004, in an attempt to improve energy efficiency and abate pressure on installed generation capacity .Energy intensive industries that did not meet specific efficiency and environmental targets were taxed under the DEPP by being forced to pay a higher electricity price (Edwards, 2012). Initially the ferroalloy, aluminum, caustic soda, cement, steel, and calcium carbide industries were subject to the pricing policy, with phosphorus and zinc smelting being included later in September 2006. Firms in these industries were divided into four categories, namely encouraged, permitted, restricted and eliminated, with the latter two (low output, low efficiency firms) paying a surcharge on the basic electricity price (Edwards, 2012). The former two categories received an adjustment to the provincial wholesale electricity price. Surcharges for restricted and eliminated enterprises were 5 fen and 20 fen per kwh respectively, approximately 10%-20% of the basic price (Price et al, 2010). The objective was to drive inefficient firms out of the market or to force innovation or investment in less energy-intensive production methods.

In the context of the South African economy, the research presented here supports claims made by Ingelsi-Lotz & Pouris (2012). Namely, based on experiences in China and the research findings of Lin & Lui (2011) and Edwards (2012) the introduction of alternative demand-side electricity management policies, such as time of use, which punishes inefficient users and a more diversified pricing schedule (that places the highest cost burden on the country's industrial and commercial consumers that are least efficient) should be supported in South Africa. Ultimately, such electricity pricing strategies should help incentivise energy efficiency improvements and encourage the development of renewable energy resources and smart-grid technologies within the country.

6 Conclusion

Government intervention in the form of taxes and surcharges can discourage investment in a particular target industry, reducing its share of GDP over time. The challenge to policy makers is to implement these surcharges in a manner that inflicts the least damage on output and employment. The negative economic impacts associated with an increase in the price of electricity in South Africa could be minimised if the price increases are diversified amongst high electricity consuming industries (such as non-ferrous metals, iron & steel, mining and non-metallic minerals). By employing a differential pricing policy, as in the case of China, the South African authorities can target electricity-intensive industries by charging them higher tariffs in order to encourage greater production efficiency and reduce aggregate electricity demand. A differential tariff structure would raise the cost of energy inefficiency and induce a re-optimisation of production processes so that more material inputs and fewer energy inputs are used in energy-intensive industries. A differential electricity pricing regime would drive out the least electricity-efficient industries in the long term, changing the structure of the economy to one that is less energy-intensive, with a smaller carbon footprint. In so doing, the adverse impact of structural changes of the South African economy on economy-wide energy efficiency as highlighted in research work by Inglesi-Lotz & Pouris (2012) are brought into check. Our estimates of the long-run responsiveness of South Africa's industrial electricity consumption to price increases suggest that those industries which would make ideal targets for such a differential electricity pricing scheme are the mining, construction, paper, pulp & print and iron & steel industries. Our industrial electricity consumption elasticities suggest that the iron & steel industry would even respond to such price increases in the short-run.

While maybe not as immediately obvious, the long-run costs of a chronic electricity supply deficit on growth of industrial output certainly outweigh the short-run job and production losses resulting from and an electricity price increase. A study by Deloitte (2009) found that scheduled load-shedding at 10% of total annual capacity would shrink South African GDP by as much as 0.7%, and noted that although difficult to quantify, the adverse impact of unscheduled blackouts would be far greater. The effects of an insufficient and unreliable electricity supply are not limited to industries in which electricity is a key input. As the output of firms in electricity-intensive industries is constrained by an electricity supply shortage, so their demand for other inputs is reduced. In this way the impact of a supply deficit can be seen as truly economy-wide, as, theoretically, even industries which do not utilise electricity in production may suffer.

References

[1] Al-Mansour, F., Merse, S., Tomsic, M. (2003) Comparison of energy efficiency strategies in the industrial sector of Slovenia. Energy 28(5): 421-440.

[2] Beenstock, M., Goldin, E., Nabot, D. (1999). The demand for electricity in Israel. Energy Economics 21(2): 168–183.

[3] Bose, R.K., Shukla, M. (1999). Elasticities of electricity demand in India. Energy Policy 27(3): 137–146.

[4] Deloitte. (2009). Estimating the Elasticity of Electricity Prices in South Africa. Johannesburg.

[5] Department of Minerals and Energy (DME). (1998). White paper on energy policy. Pretoria: Department of Minerals and Energy; 1998.

[6] Department of Minerals and Energy (DME). (2005). Energy efficiency strategy of the Republic of South Africa. Pretoria: Department of Minerals and Energy; 2005

[7] Department Of Energy (DoE). (2012). Energy Price Report 2011. Pretoria

[8] Department of Energy (DoE). (various issues). Energy balances. Pretoria: Department of Energy. Available at: http://www.energy.gov.za/files/media/media_energy_balances.html

[9] Dilaver, Z., Hunt, L.C. (2011). Industrial electricity demand for Turkey: A structural time series analysis. Energy Economics 33(3): 426-436.

[10] Edwards, T. (2012). China's Power Sector Restructuring and Electricity Price Reforms. Asia Paper: 6(2).

[11] Engle, R.F., Granger, C.W.J. (1987). Co-integration and error correction: representation, estimation and testing. Econometrica 55(2): 251–276.

[12] Fawkes, H. (2005) Energy efficiency in South African industry. Journal of Energy in Southern Africa. Vol.16(4).

[13] Fine, B., and Rustomjee, Z. (1996). The Political Economy of South Africa. From Minerals-Energy Complex to Industrialisation, London, Hurst.

[14] Fisher-Vanden, K., Mansur, E., Wang, Q. (2013). Costly Blackouts? Measuring Productivity and Environmental Effects of Electricity Shortages.

[15] Fleiter, T., Fehrenbach, D., Worelli, E., Eichhammer, W. (2012) Energy efficiency in German pulp and paper industry – A model-based assessement of savings potential. Energy 40(1): 84-99.

[16] Greenpeace, (2012). The Eskom Factor: Power politics and the electricity sector in South Africa. The Electricity Governance Complex.

[17] Haji, S., Haji, H. (1994). A Dynamic Model of Industrial Energy Demand in Kenya. Energy Journal 15(4): 203-224.

[18] He, Y.X., Yang, L.F., He, H.Y., Luo, T., Wang, Y.J. (2010). Electricity demand price elasticity in China based on computable general equilibrium model analysis. Energy 36: 1115-1123.

[19] Human Sciences Research Council. (2008). The Impact of Electricity Price Increases and Rationing on the South African Economy.

[20] Inglesi-Lotz, R., & Blignaut, J. N. (2011a). Electricity intensities of the OECD and South Africa: A comparison. Working Paper 204 - University of Pretoria, NA.

[21] Inglesi-Lotz R., Blignaut J. (2011b). Estimating the Price Elasticity of Demand for Electricity by Sector in South Africa. South African Journal of Economic and Management Sciences 14: 449-465.

[22] Inglesi-Lotz R., Pouris A. (2012). Energy efficiency in South Africa: A decomposition exercise. Energy 42: 113-120.

[23] International Energy Agency (IEA). (2012). Energy Balances for Non-OECD Countries.

[24] Kamerschen, D.R., Porter, D.V. (2004). The demand for residential, industrial and total electricity, 1973-1998. Energy Economics 26(1): 87–100.

[25] Kraft, J., Kraft, A. (1978). On the Relationship between Energy and GNP. Journal of Energy and Development 3, 401-403.

[26] Lam, P. (2001). Pricing of electricity in China. Energy 29: 287-300.

[27] Levine, M.D., Koomey, J.G., Price, L.,Geller, H., Nadel, S. (1995) Electricity end-use efficiency: Experience with technologies, markets, and policies throughout the world. Energy 20(1): 37-61.

[28] Lin B., Liu J. (2011) Principles, effects and problems of differential power pricing policy for energy. Energy 36(1): 111-118.

[29] Madlener, R., Bernstein, R., Gonzalez, M. (2011). Econometric Estimation of Energy Demand Elasticities. E.ON Energy Research Center Series 3(8).

[30] Mukherjee, K. (2008). Energy use efficiency in U.S. manufacturing: A nonparametric analysis. Energy Economics 30(1): 76-96.

[31] Nilsson, L.J. (1993). Energy intensity trends in 31 industrial and developing countries 1950-1988. Energy 18(4): 309-322.

[32] OECD. (2013). OECD Economic Surveys: South Africa 2013, OECD Publishing.

[33] Pesaran, P., Pesaran, M.H., (2009). Time series econometrics using Microfit 5.0. Oxford University Press, Oxford.

[34] Pesaran, M.H., Shin, Y. (1999). An autoregressive distributed-lag modelling approach to cointegration analysis. In: Strom, S. (Ed.), Econometrics and Economic Theory in the 20th Century. Cambridge University Press, Cambridge.

[35] Pesaran, M.H., Shin, Y., Smith, R.J. (2001). Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics 16: 289–326.

[36] Pesaran, M.H., Smith, R.P., Akiyama, T. (1998). Energy Demand in Asian Developing Economies Oxford University Press, Oxford.

[37] Polemis, M.L. (2007). Modeling industrial energy demand in Greece using cointegration techniques. Energy Policy 35(8): 4039–4050.

[38] Price L, Wang X, Yun J, (2010). The challenge of reducing energy consumption of the Top-1000 largest industrial enterprises in China. Energy Policy 38: 6485-6498

[39] Quantec. (various issues). Quantec standardised industry database. Pretoria: Quantec.

[40] Sebitosi, A.B. (2008). Energy efficiency, security of supply and the environment in South Africa: Moving beyond the strategy documents, Energy 33(11): 1591-1596.

[41] Siddayao, C.M. (1983). Pricing policy and efficient energy use. Energy 8(1-2): 45-68.

[42] Statistics SA (various issues). Consumer price index. Pretoria: StatsSA.

[43] Stern, D. (2012). Interfuel substitution: A Meta-Analysis. Journal of Economic Studies 26(2): 307-331.

[44] Sun, J.W. & Ang, B.W. (2000). Some properties of an exact energy decomposition model. Energy 25(12): 1177-1188.

[45] Taylor L.D. (1975). The Demand for Electricity: A Survey. The Bell Journal of Economics 6(1): 74-110.

[46] The World Bank. (2012). Eskom Power Investment Support Project Fact Sheet

[47] Wang, J., Bloyd, C.N., Hu, Z., Tan, Z. (2009). Demand response in China. Energy 35: 1592-1597.

[48] Winkler, H., Marquand, A. (2009). Changing development paths: From an energy-intensive to low-carbon economy in South Africa. Climate and Development 1: 47-65.

Table 1: Electricity intensity: South Africa and Rest of World (GWh/PPP adj. $ million)

	1971	1980	1990	2000	2010	Change
OECD	0.249	0.269	0.267	0.264	0.253	1%
EU-27	n/a	n/a	0.223	0.211	0.204	-8%
Non-OECD	0.196	0.220	0.272	0.264	0.277	42%
China	0.360	0.443	0.345	0.301	0.371	3%
Russia	n/a	n/a	0.442	0.483	0.362	-18%
South Africa	0.258	0.383	0.493	0.553	0.451	75%

Source: Own calculations based on IEA (2012)

Table 2: South African Electricity Consumption by Economic Sector (MWh)

	1989	%	2010	%
Industry excl mining	57 480 112	41.72	88,864,830	41.54
Mining	34 667 867	25.16	28,772,620	13.45
Transport Sector	4 229 831	3.07	3,640,190	1.70
Agriculture	3 438 991	2.50	6,163,900	2.88
Non-specified (Other)	12 000 000	8.71	14,211,860	6.64
Commerce and public Services	14 445 983	10.48	30,412,450	14.22
Residential	21 518 989	15.62	41,844,740	19.56
Total Economy	**137 781 773**	**100.00**	**213,910,590**	**100.00**

Source: DoE Energy Balances & IEA Energy Balances for Non OECD countries various issues.

Table 3: SA industrial electricity intensity: 1989-2010

Industrial Sector	1989	1999	2010	Ave
Non-ferrous metals	0.6609	0.5836	0.6523	0.5964
Iron & steel	0.2541	0.4211	0.2173	0.3108
Non-specified industry	0.2424	0.3248	0.2548	0.2618
Mining	0.2596	0.1608	0.1798	0.1914
Non metals	0.0539	0.0552	0.0827	0.0724
Chemical & Petro	0.0535	0.0141	0.0380	0.0338
Wood & products	0.0475	0.0389	0.0123	0.0222
Paper & print	0.0216	0.0217	0.0230	0.0244
Tex, leather & foot	0.0120	0.0114	0.0167	0.0120
Food, bev & tob	0.0037	0.0044	0.0040	0.0042
Machinery & equipment	0.0024	0.0007	0.0005	0.0005
Transp equipment	0.0001	0.0002	0.0003	0.0005
Construction	0.0002	0.0003	0.0004	0.0004
Total industry	**0.1078**	**0.0921**	**0.0715**	**0.0842**

Source: DoE Energy Balances & IEA Energy Balances for Non OECD countries various issues.

Table 4: Industrial electricity demand studies and elasticity estimates

			Elasticity estimates	
Study	**Country**	**Method**	**Output**	**Price**
Fisher & Kaysen (1962)#	US	OLS		-1.25
Baxter & Rees (1968)#	UK	OLS		-1.50
Anderson (1971)#	US	OLS		-1.94
Mount el al (1973)#	US	Pooled OLS		LR: -1.82 SR: -0.22
Haji & Haji (1994)	Kenya	OLS		-0.09 to -0.78
Beenstock et al (1999)	Israel	Cointegration	LR: 0.99 to 1.22	LR: -0.31 to -0.44
Bose & Shukla (1999)	India	Pooled regression	0.49 to 1.06	SR: -0.04 to -0.45
Kamerschen & Porter (2004)	USA	Simul.equations		-0.34 to -0.55
Polemis (2007)	Greece	Cointegration	LR: 0.85 SR: 0.61	LR: -0.85 SR: -0.35
He et al (2010)	China	CGE model		LR: -0.017 to -0.019
Dilaver & Hunt (2011)	Turkey	Cointegration	0.15	-0.16
Madlleber et al (2011)	Germany	Cointegration	LR: 0.7 to 1.9 SR: 0.17 to 1.02	LR: 0.00 to -0.52 SR: -0.31 to -0.57

SR short-run; LR long-run
These studies are reviewed in Taylor (1975)

Table 5: Bounds F-tests for a cointegration relationship

	Lag length Two $Fe\ (e \mid q, p\ ) =$
Total industry	6.966***
Non-ferrous metals	4.996**
Iron & steel	7.808***
Mining	1.807
Non metals	-
Chemical & Petro	6.921***
Wood & products	3.186
Paper & print	6.006***
Tex, leat & foot	-
Food, bev & tob	2.444
Machinery & equipment	-
Transp equipment	1.913
Construction	1.062

Notes: ***, ** and * denote significance at the 1%, 5% and 10% level, respectively.

Table 6: Long-run coefficients for sector-specific ARDLs

Sector **Order of ARDL**	**Constant**	**Dummy**	**Output**	**Price**
Total Industry ARDL(1,0,0,0)	**11.387***** **(0.000)**	**-0.168**** **(0.042)**	**0.511***** **(0.001)**	**-0.738**** **(0.028)**
Non-ferrous M ARDL(1,2,0,0)	12.061** (0.023)	-0.821** (0.030)	0.428 (0.322)	0.081 (0.836)
Iron & steel ARDL(2,0,0,2)	7.148 (0.523)	0.579* (0.084)	0.520 (0.377)	-2.838*** (0.001)
Mining ARDL (1,0,0,0)	15.125*** (0.000)	0.118*** (0.000)	0.235* (0.057)	-0.268*** (0.002)
Chemicals ARDL(1,1,1,0)	-6.526 (0.142)	0.625** (0.016)	1.921*** (0.000)	-0.441 (0.428)
Wood & product ARDL(1,2,0,1)	32.684*** (0.000)	-0.297 (0.268)	1.600*** (0.002)	-1.447 (0.159)
Paper & print ARDL(1,1,2,1)	-9.602 (0.329)	-1.000 (0.130)	1.297*** (0.009)	-3.404** (0.018)
Food, bev & tob ARDL(2,0,0,2)	6.030 (0.388)	-1.191 (0.226)	0.373 (0.444)	1.130 (0.598)
Transp equipment ARDL(1,0,1,0)	-12.772 (0.127)	-0.170 (0.765)	2.239*** (0.001)	-1.001 (0.493)
Construction ARDL(1,0,0,0)	-4.905 (0.668)	-0.534 (0.522)	1.621* (0.068)	-1.211** (0.024)

Notes: ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. *p*-values are reported in brackets.

Table 7: Error correction representations for the underlying ARDL models

Sector	**ECT_{t-1}**	**Δe_{t-1}**	**Δq_t**	**Δq_{t-1}**	**Δp_t**	**Δp_{t-1}**	**dummy**
Total industry	-0.782*** [0.003]		0.399** [0.022]		-0.024* [0.081]		-0.131** [0.016]
Non-ferrous Metals	-0.410** [0.020]		0.176 [0.366]		0.033 [0.829]		-0.282** [0.045]
Mining	-0.630**- [0.021]		0.094 [0.600]		-0.106 [0.329]		0.050 [0.230]
Iron & Steel	-0.148 [0.837]		0.420*** [0.003]	0.973 [0.156]	-1.738*** [0.000]	-1.426 [0.124]	0.579* [0.080]
Chemicals	-1.032*** [0.000]		-2.396 [0.128]		-0.456 [0.436]		-0.055 [0.850]
Wood & products	-0.600*** [0.018]		-0.683 [0.563]	-2.282* [0.077]	-0.869 [0.138]		-0.178 [0.305]
Paper, pulp & print	-0.314** [0.069]		1.532*** [0.001]	0.889* [0.062]	0.215 [0.380]		-0.198** [0.035]
Food, bev & tob	-0.252 [0.181]	-0.801*** [0.004]	0.094 [0.579]		0.055 [0.685]	-0.805** [0.030]	-0.230*** [0.000]
Transport	-0.470* [0.068]		1.209*** [0.002]		-0.471 [0.499]		-0.080 [0.763]
Construction	-0.458** [0.049]		0.743 [0.192]		-0.555 [0.591]		-0.245 [0.526]

Notes: ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. *p*-values are reported in brackets.

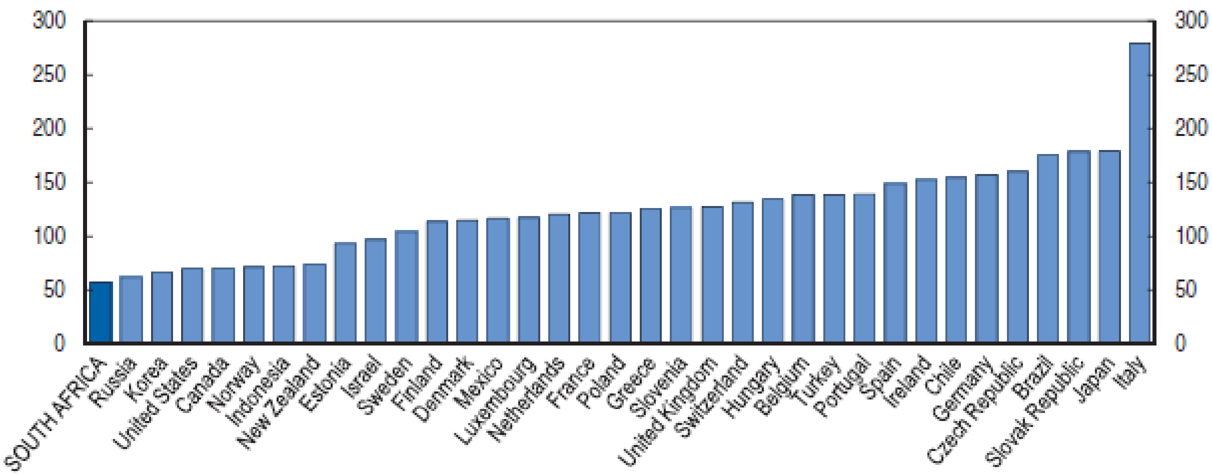
Table 8: Diagnostic tests for the underlying ARDL models

	Lagrange multiplier statistics		
Sector	**Serial correlation: χ^2_{SC} (1)**	**Normality: χ^2_N (2)**	**Heteroscedasticity: χ^2_H (1)**
Total industry	0.005 [0.994]	46.382 [0.000]	0.765 [0.382]
Non-ferrous M	1.366 [0.242]	0.934 [0.627]	0.474 [0.491]
Iron & Steel	5.495 [0.019]	1.272 [0.529]	0.030 [0.862]
Mining	0.155 [0.694]	1.687 [0.430]	1.173 [0.279]
Chemicals	0.012 [0.913]	0.480 [0.787]	0.032 [0.858]
Wood & products	0.680 [0.410]	2.792 [0.248]	0.174 [0.677]
Paper, pulp & print	1.986 [0.159]	0.734 [0.693]	0.172 [0.678]
Food, bev & tob	0.098 [0.754]	0.486 [0.784]	0.264 [0.608]
Transport	2.065 [0.151]	1.376 [0.503]	0.094 [0.760]
Construction	0.114 [0.736]	10.183 [0.006]	0.595 [0.807]

Notes: p-values are reported in brackets.

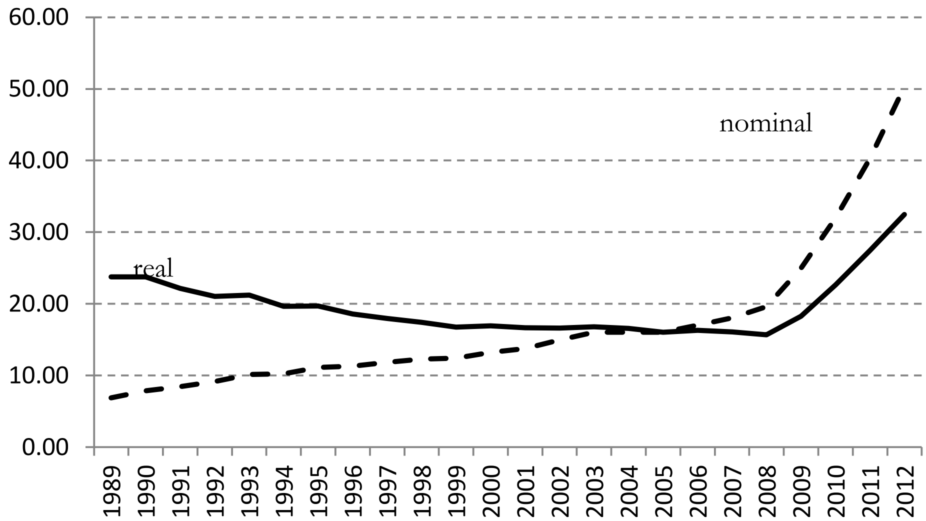
Figure 1. Industrial Electricity price, international comparison

2011 or latest year available, USD per MWh



Source: IEA (2012) Energy Prices and Taxes, OECD Estimates and ESKOM.

Figure 2. SA Industrial Electricity price 1989-2012, nominal versus real
(SA cents per MWh)



Source: Eskom & Own Calculations using StatsSA cpi data