Who would really pay for increased electricity prices in South Africa[1]

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Abstract

The paper uses a static computable general equilibrium (CGE) model of South Africa and simulates various shocks to the price of electricity. We try different closures to the model and compare their respective effects on the consumer price index, which in a CGE model is measuring real appreciation of the exchange rate, or international trade competitiveness. In general we conclude that electricity prices per se do not have a significant influence on the real exchange rate, no matter which closure is used.

INTRODUCTION

Few would deny the importance of electricity as an essential input to production and to economic activity in general. Based on the fact that changes in electricity prices impact on basically each and every person in South Africa, it is important to determine its effect on the real exchange rate in South Africa. Salvatore (2004) defines the real exchange rate as the nominal exchange rate multiplied by foreign consumer price index divided by local consumer price index. In our model both the nominal exchange rate and foreign prices are exogenous (and therefore constant if not shocked), so that movements in the domestic CPI shows exactly the inverse of the movements in the real exchange rate. The paper starts with an overview of electricity prices in South Africa, and concludes with empirical analysis using a computable general equilibrium (CGE) model.

[1] The paper is currently under review at the ERSA Working Paper Series with a changed title "**On the real exchange rate effects of higher electricity prices in South Africa"** The paper originated from a brief study done for the National Electricity Regulator (NER) (later the National Energy Regulator of South Africa -NERSA) in South Africa in which we found very small inflationary effects by higher electricity prices. We would hereby like to thank the NER for their financial support and stress that the contents of the paper does not in any way reflect the views of the NER, but only of the authors. We would also like to thank Mark Horridge at the Centre of Policy Studies in Melbourne for valuable comments.

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OVERVIEW OF ELECTRICITY PRICES

International comparisons

Electricity to consumers in SA is known to be the second cheapest in the world, beaten only by New Zealand (Doppegieter *et al*., 1999). This is shown by the fact that the cost of electricity as a percentage of total cost to company is very low, in most cases less than five per cent, while electricity's contribution to GDP is only approximately 3,5 per cent. It is therefore not surprising that the demand for electricity is relatively insensitive to changes in price as measured by the elasticity of demand. The implicit financial subsidy on electricity prices is clear from the figures of Table 1, which gives an international perspective on electric power prices. South Africa's US$0.01/kWh price on electricity for industry is matched by no other country and only India (US$0.04/kWh) comes close to the retail prices of electricity for households of US$0.03/kWh charged in South Africa. The average international price of electricity for industrial use in 2004(1) was $0.10/kWh for upper income countries and $0.06/kWh for developing countries, and $0.14/kWh and $0.09/kWh respectively, for household use.

Table 1: Retail electricity prices: International comparisons: 2004

Upper-income countries			**Developing countries**		
	Electricity for industry US$/kWh	**Electricity for households US$/kWh**		**Electricity for industry US$/kWh**	**Electricity for households US$/kWh**
Australia	0.36	0.06	Czech Republic	0.06	0.09
Belgium	-	-	Greece	0.06	0.11
France	0.05	0.14	Hungary	0.09	0.13
Germany	0.05	0.14	India	-	0.04
Italy	0.15	0.20	Korea	0.05	0.07
Japan	0.12	0.17	Mexico	0.06	0.10
Netherlands	-	0.22	Poland	0.06	0.10
New Zealand	0.05	0.12	Slovak Republic	0.08	0.12
Spain	0.05	0.11	**South Africa**	**0.01**	**0.03**
United Kingdom	0.06	0.13	Taipei	0.05	0.07
United States	0.05	0.08	Turkey	0.09	0.10
Average	**0.10**	**0.14**	**Average**	**0.06**	**0.09**

Source: IEA, 2004.

Trends in electricity prices

One can clearly see from Table 2 the large differences in electricity prices on different users in South Africa. In 2005 Households (38.7 c/kWh) and Agriculture (30.8 c/kWh) paid the highest rates for electricity, whereas Manufacturing and Mining continued to pay much lower prices (13.97 c/kWh and 15.36 c/kWh respectively) - less than half of what domestic users paid. One reason for this is that the number of clients serviced in the domestic sector is much larger than those in Manufacturing and Mining, who consume about 65 per cent of total electricity. This indicates that Manufacturing and Mining receive bulk sales at lower prices.

Table 2: Overview of electricity prices & sales in South Africa: 1992-2004

	1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Electricity consumption in GWh												
Manufacturing	42,122	43,681	43,014	47,481	55,073	61,070	72,663	70,796	70,665	74,778	83,581	78,79
Mining	33,962	32,026	32,668	33,176	34,831	30,390	29,204	28,877	29,038	31,691	32,204	30,79
Transport	4,629	4,017	4,389	4,297	4,274	4,563	4,639	4,429	5,411	5,562	6,246	5,56
Agriculture	4,038	3,108	4,880	5,301	5,103	5,640	5,627	5,755	3,954	4,175	4,644	5,14
Commerce	17,484	13,586	14,058	17,307	19,768	22,170	13,974	17,709	17,164	18,301	18,227	21,07
Residential	24,253	21,542	22,115	24,369	29,552	30,722	30,163	29,511	28,680	34,623	30,418	34,07
Total	126,488	117,960	121,124	131,931	148,601	154,555	156,270	157,077	154,912	169,130	175,320	175,44
Eskom revenue in c.kWh												
Manufacturing	8.17	8.35	8.91	10.4	10.1	10.78	11.02	10.56	11.94	11.56	12.88	14.1
Mining	8.79	9.52	10.11	10.62	11.02	11.66	12.22	12.61	12.91	13.35	14.14	15.0
Transport	12.44	13.7	14.31	14.65	15.31	15.04	14.9	15.19	15.35	15.69	17.15	18.9
Agriculture	17.14	19.84	21.13	21.99	23.39	24.66	26.42	26.58	28.88	26.85	26.47	29.1
Commerce	15.57	16.46	17.43	18.65	19.49	20.23	18.85	22.27	22.64	17.95	19.51	20.6
Residential	15.27	12.68	16.76	18.15	19.45	21.33	22.74	25.36	27.7	30.9	33.43	36.5
Average	9.16	10.14	10.26	11.15	11.3	11.95	12.29	12.44	13.23	13.76	14.98	16.0

Sources: DME. 2006. Digest of energy statistics 2006 and DME. 2005. Price report 2005.

In general, electricity prices in SA have declined in real terms since Eskom announced its *price compact* in 1991 with the conviction that cheap electricity is essential for rapid economic growth (Van Horen, 1996). Under the *price compact*, Eskom undertook to decrease the real price of electricity substantially. Table 3 shows that the real price of electricity for all sectors declined by 11 per cent, whereas the real price for the industrial sector decreased by 25 per cent over the period 1970-2005. Since 1990, the price of electricity for all sectors declined by 43 per cent, while for Manufacturing the price dropped by 53 per cent.

Table 3: Real electricity prices in South Africa: 1970-2004/5 (2000=100) (c/kWh)

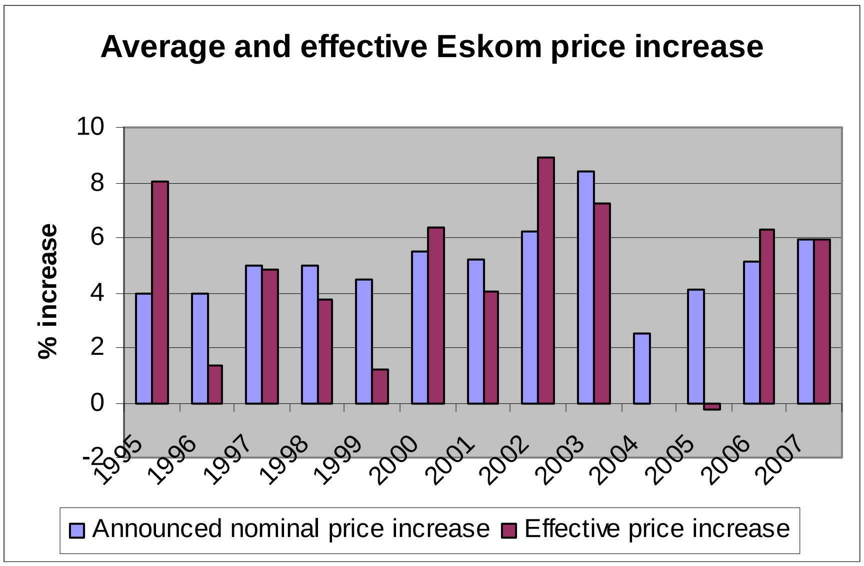
	Ave: all sectors		**Industrial**			**Ave: all sectors**		**Industrial**	
	Real price	**% change**	**Real price**	**% change**		**Real price**	**% change**	**Real price**	**% change**
1970	14.36		14.1		**1988**	19.44	-3.1%	18.18	-4.9%
1971	13.94	-3.0%	13.7	-2.9%	**1989**	18.6	-4.5%	17.44	-4.2%
1972	13.8	-1.0%	13.57	-1.0%	**1990**	18.56	-0.2%	17.27	-1.0%
1973	13.43	-2.8%	13.22	-2.6%	**1991**	17.31	-7.2%	15.9	-8.6%
1974	12.62	-6.4%	13.17	-0.4%	**1992**	16.43	-5.4%	14.66	-8.5%
1975	13.09	3.6%	13.42	1.9%	**1993**	15.58	-5.5%	13.65	-7.4%
1976	15.32	14.6%	15.61	14.0%	**1994**	15.4	-1.2%	13.37	-2.1%
1977	20.4	24.9%	20.66	24.4%	**1995**	15.4	0.0%	14.36	6.9%
1978	21.28	4.1%	21.41	3.5%	**1996**	14.54	-5.9%	12.99	-10.5%
1979	19.98	-6.5%	19.87	-7.8%	**1997**	14.04	-3.6%	12.77	-1.7%
1980	18.65	-7.1%	18.74	-6.0%	**1998**	13.62	-3.1%	12.21	-4.6%
1981	18.27	-2.1%	18.27	-2.6%	**1999**	13.11	-3.9%	11.13	-9.7%
1982	19.58	6.7%	19.79	7.7%	**2000**	13.23	0.9%	11.94	6.8%
1983	20.93	6.5%	21.05	6.0%	**2001**	13.02	-1.6%	10.94	-9.1%
1984	19.99	-4.7%	20.1	-4.7%	**2002**	13.01	-0.1%	11.19	2.2%
1985	19.77	-1.1%	19.77	-1.7%	**2003**	13.14	1.0%	11.6	3.5%
1986	20.16	1.9%	20.36	2.9%	**2004/05**	12.96	-1.4%	11.28	-2.8%
1987	20.04	-0.6%	19.07	-6.8%	**Ave. over period**	16.37	-10.8%	15.62	-25.0%

Source: DME (2005).

The relatively low electricity prices could be attributed to a number of factors. First, Eskom enjoyed relatively low production costs in terms of the value of its key inputs (coal), and, hence, a low marginal cost of production – operations only (estimated to be between 4 and 5c/kWh), which allowed Eskom fairly high average profit margins.

Figure 1 illustrates Eskom's announced and effective price adjustments since 1995. The announced price increases are the increases as approved by the National Energy Regulator of South Africa (NERSA), whereas the effective price increases illustrate what the actual increases that was in effect as reflected in Eskom's balance sheet for the relevant year. The reason for the difference between announced and effective increases is due to the difference between projected and actual sales, as well as structural changes to prices. In 1995, 2000, 2002 and 2006 the effective price[4] increase experienced was above the price increase granted. No data was available for the effective price increase in 2004 and in 2005 the effective price increase was actually negative.

Figure 1: Average announced and effective Eskom price increases



Source: Eskom yearbook, various editions.

Table 4 shows the percentage change in Eskom's average prices per customer category after each annual price adjustment during the period 1994 to 2002.

[4] Effective increase refers to the actual increase that occurred during a year.

Table 4: Percentage change in Eskom average prices per customer category (nominal rand)

Percentage changes in Eskom Average Prices per customer group									
	Eskom average price increase %	Domestic	Agriculture	Commercial	Traction	Mining	Industrial	Redistributors	Effective price increase %*
1994									
1995	4.0%	8.38	4.05	7.42	2.38	4.96	16.74	5.84	8.03
1996	4.0%	7.10	6.27	4.11	4.61	3.81	-2.87	3.38	1.38
1997	5.0%	9.73	5.52	4.15	-1.92	5.81	6.68	2.49	4.87
1998	5.0%	6.61	7.11	-6.79	-0.96	4.77	2.21	1.86	3.71
1999	4.5%	11.51	0.62	18.11	2.02	3.20	-4.16	1.73	1.20
2000	5.5%	9.24	8.64	1.70	1.03	2.37	13.05	3.17	6.35
2001	5.2%	11.54	-7.04	-20.66	2.40	3.42	-3.18	5.87	4.06
2002	6.2%	8.19	-1.42	8.62	9.16	5.97	10.75	9.05	8.9
2003	8.43%								7.21
2004	2.50%								
2005	4.10%								-0.26
2006	5.10%								6.26
2007	5.90%								5.93

Source: NERSA (2004) and Eskom Annual reports.

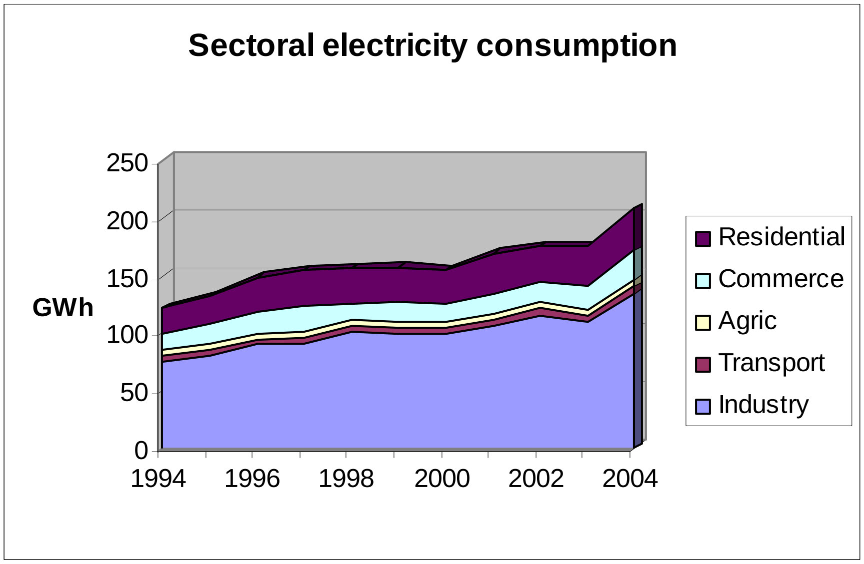
**Effective increase refers to the actual increase that occurred in a year*

As shown in Table 4, in nominal terms prices in general had an upward trend. However, if this is compared with the effective annual price increase, it is evident that these increases did not necessarily follow a general upward trend, except for the last couple of years. As stated before, these price changes originated from a fairly low base and as such represented marginal changes with a fairly high level of volatility.

Electricity consumption

The sectoral distribution of electricity consumption in South Africa provides some insight into the relative importance of each sector in terms of consumption. Consumption in the following groups: residential, commerce, agriculture, transport and industry are given, using the DME price report data set. The relative consumption of each of these groups is illustrated in Figure 2.

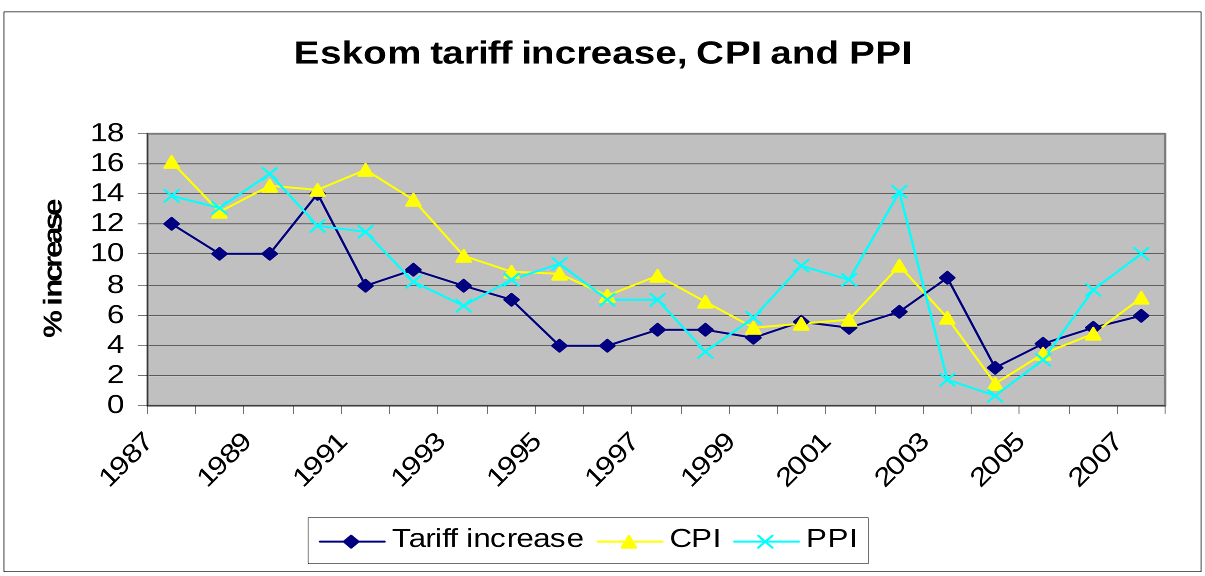
Figure 2: Sectoral electricity consumption in South Africa: 2004: Eskom sales



Source: DME 2006: Digest of South African energy statistics.

From Figure 2 it is evident that the bulk supply of electricity to municipalities (which include residential, industrial and commercial demand for electricity) comprises the largest component of electricity consumption, followed by the agriculture and transport consumption thereof. It should be noted that these sales reflect the direct sales of Eskom to these sectors.

Figure 3: CPI, PPI and average Eskom price increase



Source: StatsSA and NERSA approvals.

Figure 3 shows that there is a relationship between electricity prices and the two most studied price indices, namely the CPI and the PPI. However, the CGE model is not well-suited to comment on the causality of these relationships, since it is a relative price model. What is important from this figure, and from Table 5 below, is that electricity prices have generally increased by less than the inflation rate in most time periods, and a correction is probably unavoidable, as demanded by Eskom.

Table 5: Comparison of the average Eskom price increase to consumer inflation

Year	Eskom average price increase (%)	Inflation rate (%)
1987	12.00	16.20
1988	10.00	12.90
1989	10.00	14.50
1990	14.00	14.30
1991	8.00	15.60
1992	9.00	13.70
1993	8.00	9.90
1994	7.00	8.80
1995	4.00	8.70
1996	4.00	7.30
1997	5.00	8.60
1998	5.00	6.90
1999	4.50	5.20
2000	5.50	5.40
2001	5.20	5.70
2002	6.20	9.20
2003	8.43	5.80
2004	2.50	1.40
2005	4.10	3.42
2006	5.10	4.70
2007 (projected)	5.90	7.10

Source: Eskom yearbook, various editions and STATSSA.

To enable a more detailed analysis of the impact of a change in electricity prices on the real exchange rate of South Africa, different scenarios are analysed using a computable general equilibrium (CGE) model. Since a CGE-model takes all inter-industry adjustments into account, also that of a decline in demand, before it arrives at an equilibrium price level, the results are different from those of partial equilibrium models that simply multiply a change in price with the CPI weight associated with electricity. Partial analysis models usually assume that demand remains constant irrespective of changes in the level of the price and is clearly inconsistent with economic theory. In such models the effects of price increases will be over-estimated.

DATA AND MODEL

The data used in the paper is the official 1998 social accounting matrix (SAM) of South Africa, developed by Statistics SA (SSA 2001). The SAM divides households into 12 income and 4 ethnic groups, and distinguishes between 27 sectors. The elasticities used for the CES functions in the model have been taken from De Wet (2003), who estimated them using time-series data.

The model is the static computable general equilibrium (CGE) model of the Department of Economics at the University of Pretoria, called UPGEM. It is similar to the ORANI-G-model of the Australian economy, and is written and solved using GEMPACK (Harrison and Pearson 1996), a flexible software system for solving CGE models. In general, the model allows for limited substitution on the production side while it focuses on substitution in consumption. It is a static model with an overall Leontief production structure and CES[5] sub-structures for (i) the choice between labour, capital and land; (ii) the choice between the different labour types in the model; and (iii) the choice between imported and domestic inputs into the production process. Household demand is modelled as a linear expenditure system that differentiates between necessities and luxury goods, while households' choices between imported and domestic goods are modelled using the CES structure.

Assumptions

We model both the short run and long run effects of an increase in the price of electricity. The standard closures[6] are described here, but in the scenarios that we model we make slight adjustments to the closures in our quest to understand the impact of electricity price increases. In the short-run the capital stock is assumed fixed, while the rate of return on capital is allowed to change. The labour market is modelled in the typical ORANI way, which assumes fixed real wages in the short run, and an infinite supply of labour at the given real wage. This is a fairly

[5] Constant elasticity of substitution.

realistic assumption of the South African labour market with its large unemployment of unskilled labour. The supply of land is also assumed inelastic. In the long run the real rate of return on capital is fixed, with capital being allowed to adjust, while employment is fixed, with adjusting real wages.

With reference to the macroeconomic variables, it is assumed that aggregate investment; government consumption and inventories are exogenous, while consumption and the trade balance are endogenous in the short run. It differs slightly from the ORANI assumptions of fixed real household consumption in the short run, because this specification allows us insight into the effect of the suggested policies on South Africa's consumption and competitiveness. In the long run we follow the usual ORANI closure with C, I and G[7] endogenous, and the Balance of Trade exogenous[8]. All technological change variables and all tax rates are exogenous in the closure. Finally, the nominal exchange rate is set to be the numeraire in each of the simulations.
The focus of the paper is the impact of electricity prices on the real exchange rate, as measured by the CPI variable in our model. To shed light on this question various shocks to the model are implemented, while altering some key assumptions about employment and consumer behaviour.

THE SCENARIOS

Eleven simulations are run to determine what the influence of the following variations in the assumptions would be on the results:

(i) the difference between being able to set the price of electricity between raising a tax on electricity;

(ii) the difference between a tax on households only, versus a tax on intermediate and final use of electricity;

(iii) the difference between fixed real consumption and the standard closures;

(iv) the difference between fixed real wages and fixed nominal wages in the short run; and

(v) the effect of electricity price increases in the long run.

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[6] We use the word "closure" to indicate which variables in the model are exogenous.
[7] From the well-known macroeconomic equation Y = C + G + I + X - M
[8] No country should have continued trade deficits or surpluses in the long run.

In variation (i) we compare the situation where the government levies an additional tax of 10% on the price of electricity with the one where the electricity industry increases its own price by 10%. A CGE model has prices endogenous, i.e., they are determined by the model and could in general not be "set" by anyone. Usually prices can only be affected through some exogenous shock to the model, or in other words, through a manual change to some variable that is not endogenous. Therefore, to be able to set the price of electricity we need to change the closure of the model by making the price of electricity exogenous and another variable endogenous. The only possible way to do this is to endogenise the amount of production taxes paid by electricity, or some cost variable. The (neo-classical) model does not allow excess profits to any industry, so that the only way that they can actually do that is by either paying more taxes or experiencing higher costs. Therefore, in principle it does not matter who increases the price of electricity – the government or the electricity industry – the effects will be similar.

In variation (ii) we isolate the effect of a tax on only household consumption of electricity. In general industries pay much less for electricity than households, and some industries would often be exempted from price increases. Hence it is necessary to isolate the effect of a price increase on households. Therefore, in this scenario we model the extreme case where all industries would get a special deal from the electricity industry, while only households are targeted to pay more for electricity.

Variation (iii) is a comparison between the ORANI standard short run closure and ours described above. In ORANI household consumption expenditure is held fixed in real terms in the short run, alongside G and I. Only the trade balance is allowed to vary. We compare two ways of modelling household behaviour. Do households try to keep their real consumption levels constant in the short run, or would they let nominal consumption expenditure vary with nominal wage income? The former means that they keep total real spending on consumption constant, while the latter means they react to the price increase in electricity by altering the quantities consumed of all commodities, while also adjusting total expenditure. We study the effects of the two scenarios and comment on the results below.

A key assumption of many CGE models for the short run is fixed real wages. In variation (iv) from the standard closure we compare the situation where real wages are held fixed with the one where nominal wages are held fixed. If something bad happens in the economy, such as a new tax, and real wages are fixed, then firms will be inclined to lay workers off. By keeping nominal wages fixed in the variation, we assume that firms will rather lower real wages than lay workers off. Firms cannot continue to pay the same real wages and simultaneously employ the same number of workers when their costs increase. They must give way in either real wages or employment or a little bit of both. By allowing real wages to change, we allow a price effect. If they are kept constant, we expect to see a quantity (number of workers) effect.

The final “variation” is actually the standard long run closure. We are interested to know what the effects of a rise in the electricity price would be in the longer run. In our modelling terms we allow the capital stocks of all industries in the economy to vary, while keeping employment constant. In this way we are able to compare the effects that labour and capital have on the economy in general.

THE RESULTS

The highest increase in the real exchange rate was found when both the households and firms are paying more for electricity, and when we hold real household spending and real wages fixed at the same time. The results of the first variation are presented in Table 6 for thirteen variables, of which the consumer price index is the focus of the paper[9]. However, we are convinced that electricity prices are much more important than just their influence on relative prices, and therefore also comment on the effects on other variables. We list the relevant scenarios in the columns, and report on the macroeconomic outcomes of significant variables in the rows.

A few things stand out from Table 6. Zeros appear in the first three rows in all of the short run simulations, which indicate the initial assumption about domestic absorption on the macroeconomic level. The exceptions are the scenarios where nominal household spending is a function of wage income. The whole third last row is also filled with zeros, because import prices

(PIMP) are assumed exogenous – South Africa being a small open economy that cannot influence world prices.

Increase in administered prices versus an increase in taxes

Table 6: Comparison between a tax on electricity and an increase in its administered price – percentage changes

	f0wn	**f0wr**	**f0xn**	**f0xr**	**p1wn**	**p1wr**	**p1xn**	**p1xr**
CONS	-0.312	-0.312	0	0	-0.492	-0.504	0	0
INV	0	0	0	0	0	0	0	0
GOV	0	0	0	0	0	0	0	0
EXP	-0.098	-0.096	-0.482	-0.818	-0.239	-0.169	-0.808	-1.26
IMP	-0.186	-0.186	-0.035	-0.06	-0.291	-0.293	-0.051	-0.084
GDP	-0.177	-0.177	-0.11	-0.186	-0.3	-0.29	-0.186	-0.289
CPI	-0.001	-0.002	0.24	0.34	-0.032	-0.057	0.334	0.469
PINV	-0.006	-0.006	0.059	0.167	-0.008	-0.028	0.091	0.238
PGOV	0.004	0.002	0.03	0.319	0.002	-0.047	0.042	0.44
PEXP	0.02	0.019	0.097	0.164	0.048	0.034	0.162	0.254
PIMP	0	0	0	0	0	0	0	0
PGDP	0.012	0.011	0.194	0.352	-0.029	-0.062	0.248	0.464
EMPL	-0.31	-0.31	-0.208	-0.351	-0.52	-0.5	-0.344	-0.537

Legend: f0 industries and households pay a 10% tax on electricity
p1 prices are directly increased by 10%
w nominal household spending is a function of wage income
x real household spending is constant
n nominal wages are held fixed
r real wages are held fixed

Comparing the simulations that start with "f0" to the "p1's" (see the Legend below the Table) gives interesting but intuitive results. Levying a tax of 10% on electricity is like shifting one of the curves in a two dimensional graph of supply and demand: the new equilibrium price of electricity will be less than 10% higher due to the elasticities of demand and supply (it turns out to be 7% higher). However, with the price-simulations we force the new equilibrium price of electricity to be 10% higher, despite the values of elasticities. Hence we find from Table 6 that the changes in CPI are larger in absolute value for all the price-simulations than for the tax-simulations. The initial impacts on electricity prices are forced to be larger, and this effect works

[9] In a CGE model with nominal exchange rate fixed, the CPI is measuring real appreciation, or international trade

through the price system and influences all the price indices in the economy (see PINV, PGOV, etc in the Table).

Increase on household consumption only versus an increase on intermediate use as well

The second pair of scenarios to be compared concerns the taxpayers. The results are presented in Table 7, and the effect on CPI depends not only on the subject of the taxpayer, but also on the assumption about consumer behaviour. If real consumption is held fixed (zeros in row one of Table 7), then a tax on both industries and households leads to a higher increase in CPI. However, if nominal consumption follows nominal wage income, a tax on only households leads to a higher increase.

Table 7: Comparison between a tax on households with a tax on both households and firms – percentage changes

	f0wn	**f0wr**	**f0xn**	**f0xr**	**f3wn**	**f3wr**	**f3xn**	**f3xr**
CONS	-0.312	-0.312	0	0	-0.132	-0.097	0	0
EXP	-0.098	-0.096	-0.482	-0.818	0.253	0.027	0.091	-0.196
IMP	-0.186	-0.186	-0.035	-0.06	0	0.003	0.064	0.043
GDP	-0.177	-0.177	-0.11	-0.186	-0.021	-0.055	0.008	-0.058
CPI	-0.001	-0.002	0.24	0.34	0.103	0.185	0.204	0.29
PINV	-0.006	-0.006	0.059	0.167	-0.028	0.038	-0.001	0.09
PGOV	0.004	0.002	0.03	0.319	-0.012	0.148	-0.001	0.245
PEXP	0.02	0.019	0.097	0.164	-0.051	-0.005	-0.018	0.039
PGDP	0.012	0.011	0.194	0.352	0.05	0.157	0.126	0.261
EMPL	-0.31	-0.31	-0.208	-0.351	-0.031	-0.098	0.012	-0.11

Legend:
f0 industries and households pay a 10% tax on electricity
f3 only households pa a 10% tax on electricity
w nominal household spending is a function of wage income
x real household spending is constant
n nominal wages are held fixed
r real wages are held fixed

Fixed real household consumption versus nominal consumption as a function of nominal wages

With all pairs of simulations, the CPI is higher when real consumption is forced to stay constant. Real consumption (CONS) always decreases if it is endogenous, no matter who pays the taxes.

competitiveness.

So, if we force it to stay constant, it is higher than otherwise, with upward pressure on prices. With real consumption fixed, we are forcing households to keep their total spending constant in real terms. That does not mean they have to consume the same amount of electricity, however. Their demand for electricity decreases, but the demand for other commodities increases, since they have become relatively cheaper than electricity. This increase in demand puts upward pressure on CPI between 0.204 and 0.29 per cent (columns 7 and 8 in Table7). However, if firms also pay the tax, their costs increase and they will increase the prices of all commodities, which will increase the CPI variable by between 0.24 and 0.34 per cent (columns 3 and 4).

With household consumption adjustable, it is clear from the first row in Table 7 that real consumption decreases with a tax on electricity. It decreases more if industries also have to pay the tax, because then the prices of all commodities will be inclined to rise. In fact, we see that the first two columns on the left show a slight decrease in CPI, since consumer demand has fallen enough to contract prices in the economy. If only households pay the tax, the higher price of electricity gives a positive effect on the CPI. Only the price of electricity increases and consumers therefore only decrease their total demand slightly.

Fixed real wages versus fixed nominal wages

With all pairs of simulations, keeping the real wage fixed leads to larger movements in the CPI (compare n-simulations with r-simulations in Table 8).

Table 8: A Comparison between fixed real and fixed nominal wages – percentage changes

	f0wn	**f0wr**	**f0xn**	**f0xr**	**f3wn**	**f3wr**	**f3xn**	**f3xr**	**p1wn**	**p1wr**	**p1xn**	**p1xr**
CONS	-0.31	-0.31	0.00	0.00	-0.13	-0.10	0.00	0.00	-0.49	-0.50	0.00	0.00
EXP	-0.10	-0.10	-0.48	-0.82	0.25	0.03	0.09	-0.20	-0.24	-0.17	-0.81	-1.26
IMP	-0.19	-0.19	-0.04	-0.06	0.00	0.00	0.06	0.04	-0.29	-0.29	-0.05	-0.08
GDP	-0.18	-0.18	-0.11	-0.19	-0.02	-0.06	0.01	-0.06	-0.30	-0.29	-0.19	-0.29
CPI	-0.001	-0.002	0.24	0.34	0.10	0.19	0.20	0.29	-0.03	-0.06	0.33	0.47
PINV	-0.01	-0.01	0.06	0.17	-0.03	0.04	0.00	0.09	-0.01	-0.03	0.09	0.24
PGOV	0.00	0.00	0.03	0.32	-0.01	0.15	0.00	0.25	0.00	-0.05	0.04	0.44
PEXP	0.02	0.02	0.10	0.16	-0.05	-0.01	-0.02	0.04	0.05	0.03	0.16	0.25
PGDP	0.01	0.01	0.19	0.35	0.05	0.16	0.13	0.26	-0.03	-0.06	0.25	0.46
EMPL	-0.31	-0.31	-0.21	-0.35	-0.03	-0.10	0.01	-0.11	-0.52	-0.50	-0.34	-0.54

Fixed real wages imply that firms have to increase nominal wages with the same rate as the CPI, whenever they experience a cost increase. They will react to this by laying off workers. This is clear from the last row in Table 8 in all the columns that show increases in CPI – employment decreases more with real wages fixed than otherwise. Production of commodities in the short run depends on the amounts of capital, land and labour employed, as well as technology. Only labour can change in the short run, so that GDP will also decrease more if real wages are fixed (see the fourth row in Table 8). A decrease in supply, given a certain demand, puts upward pressure on prices. Hence, with real wages fixed, labour is laid off, which decreases supply and puts upward pressure on prices. The reverse of the argument would be true when the CPI decreases, and the Table confirms that as well.

Long run effects

The final set of simulations to be discussed is the effects of tax or price increases in the long run. The long run is characterised by a flexible capital stock, endogenous domestic demand, and an exogenous balance of trade. The results of three simulations are presented in Table 9. The last and third last rows contain zeros to indicate the assumptions of given world prices and exogenous employment growth respectively. The three columns to the right (copied from Table 8) are the short run equivalent scenarios to the three long run scenarios on the left.

Table 9: Long run effects

	lrf0	**lrf3**	**lrp1**	**f0wn**	**f3wn**	**p1wn**
CONS	-0.087	-0.012	-0.097	-0.312	-0.132	-0.492
INV	-0.365	-0.027	-0.4	0	0	0
GOV	-0.087	-0.012	-0.097	0	0	0
EXP	-0.369	0.051	-0.388	-0.098	0.253	-0.239
IMP	-0.299	0.036	-0.311	-0.186	0	-0.291
GDP	-0.155	-0.01	-0.171	-0.177	-0.021	-0.3
CPI	0.049	0.193	0.031	-0.001	0.103	-0.032
PINV	-0.14	-0.013	-0.157	-0.006	-0.028	-0.008
PGOV	-0.545	0.005	-0.583	0.004	-0.012	0.002
PEXP	0.074	-0.01	0.078	0.02	-0.051	0.048
PIMP	0	0	0	0	0	0
PGDP	-0.088	0.116	-0.132	0.012	0.05	-0.029
EMPL	0	0	0	-0.31	-0.031	-0.52

Once again the results are interesting and they confirm some of the short run conclusions drawn above. The highest increases in CPI would be experienced when a tax is levied on households only, while, an increase in the administered price would have a smaller effect than a tax on intermediate and household consumption. In the majority of scenarios depicted in Table 9 we see increases in CPI together with decreases in GDP. In a simple supply and demand diagram this would only be possible if supply shifts to the left and demand does not change enough to offset the fall in supply – positive or negative.

In the long run real wages are flexible, as well as household consumption, so that we only need to explain three pairs of comparisons: (i) why we do have increases in CPI in the long run, while similar assumptions in the short run lead to lower prices; (ii) why a tax on only households leads to larger increases in CPI, and (ii) why using an administered price leads to lower increases in CPI than a tax.

Firstly, the values for CPI are higher in the left three columns than for the similar short run situations on the right. Our assumptions about the macroeconomic variables on the demand side mainly drive the results. In the short run the changeable variables are consumption expenditure and the trade balance, while in the long run the trade balance is fixed, and C, I and G are allowed to change. Investment decreases as firms demand less capital in the long run; government consumption moves with household consumption by assumption (the percentage changes are the same in Table 9), which decreases due to price increases of commodities. In both the short run and the long run GDP decreases due to a decrease in employment of the flexible factor of production. Total demand must follow and in the short run there is a large decrease in household consumption, the only component of gross national product (GNP) that can change and which has an influence on the CPI. In the long run all three components of GNP can change, so that we find much smaller decreases in demand by households, and less downward pressure on CPI. In terms of our virtual graph of supply and demand, household demand changes less in the long run, and has a smaller offsetting affect on the increase in prices that are experienced due to a fall in supply.

Secondly, the increase in CPI is higher in both the long and short run if only households are taxed, given that household consumption and real wages are also flexible. A tax on firms increases their costs and forces them to employ less of the flexible factor of production, as before. They employ less capital and decrease production. From Table 9 it is clear that GDP decreases when firms are included in the tax, while it almost doesn't change when only households are taxed. This results in a large decrease in total demand in the long run, with downward pressure on prices. Moreover, if we look at the fourth row in Table 9 we see that exports differ markedly between the two said scenarios. When firms are included in the tax on electricity they increase the prices of their goods (actually the market does since prices are determined by marginal cost in the model), including the prices of exported goods. The result is that export demand also falls to strengthen the demand effect. If only households pay more for electricity, a decrease in demand leads to lower prices of some commodities, which stimulates export demand to counteract the falling demand effect of the tax, and hence counteracts the decrease in CPI as well.

Thirdly, in both the long and the short run CPI ends up lower if an administered price is used to model the change in the price of electricity, than with a tax. If we compare the first four rows' values of macro demand quantities, the administered price leads to larger decreases in demand because the initial shock to electricity prices is larger. The same argument holds as in the previous discussion, namely that the larger decrease in total demand leads to lower increases in CPI than the smaller decrease in total demand.

CONCLUSION

The main conclusions from the modelling exercises are:

- The direct impacts of an increase in electricity prices are mostly negative on the economy. All industry production decreases in the short run (GDP declines as well), while many industries are also worse off in the long run.
- Poorer groups are affected worse than others and care should be taken when price increases are decided on. The most efficient policy is not necessarily the most equitable.
- Exemptions to some are always carried by others, i.e., if some industries face lower increases in prices, other industries and final consumers are affected more than when everybody pays the same increase.

- When foreign consumers of electricity pay less than domestic consumers, there is cross-subsidisation from the domestic consumers to the foreigners. In general, exports and the foreign markets determine what the industry results would be of an increase in electricity prices. The effect on the terms of trade and balance of payments is important – export-driven sectors are particularly vulnerable to an electricity price hike.
- Some sectors, such as the Iron and Steel industry, are sensitive to a change in electricity prices. Electricity makes up a large proportion of their input cost, with the result that any increase in the price influences their cost significantly. Moreover, they are export-driven, and with higher costs their competitiveness are adversely affected in the world.
- The effect on the CPI in the model, and therefore on the real exchange rate is generally speaking very small. The Reserve Bank of South Africa warned against inflationary effects of higher electricity prices, but we did not find significant effects in this regard.

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