EXCHANGE RATE DEPRECIATION AND COSTS OF AGRICULTURAL INPUTS IN SOUTH AFRICA[1]

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Samevatting

Wisselkoersdepresiasie en koste van landbou-insette in Suid-Afrika

Wisselkoersdepresiasie is van ander ekonomiese invloede geïsoleer ten einde die impak daarvan op kleinhandelspryse van groepe landbou-insette in Suid-Afrika te meet. Die gekose periode was een waartydens die wisselkoers van die Rand algemeen verswak het. Probleme met seriale korrelasie is oorkom deur 'n kombinasie van die Hildreth-Lu prosedure en geweegde eerste verskille. Trekkerpryse het binne die eerste, sowel as die volgende twee kwartale gereageer. Pryse van ander insetgroepe het tussen die eerste en derde kwartale na depresiasie gereageer, en elastisiteite het gewissel tussen -0,090 en -0,698. Sommige effekte het 'n indirekte aard gehad. Statutêr geadministreerde pryse skyn nie anders opwisselkoers veranderings te reageer as pryse wat deur suiwer besigheidsbesluite gevorm word nie.

Abstract

Exchange rate depreciation was isolated from other economic influences to measure its impact on retail prices of groups of agricultural inputs in South Africa. The period selected was one of generally declining exchange rate of the Rand. Serial correlation problems were overcome by a combination of the Hildreth-Lu procedure and weighted first differences. Tractor prices reacted within the same quarter, as well as the following two quarters. Prices of other input groups reacted between the first and third quarter following depreciation, with elasticities varying between -0,090 and -0,698. Some effects were of an indirect nature. Statutory administrated prices do not seem to react differently to exchange rate depreciation than prices formed by pure business decisions.

1. Introduction

Exchange rate changes can influence the economic performance of agriculture in a variety of ways. The most obvious and direct effects are one on export realisations and on prices of imported inputs. Prices of inputs, components of which are imported for local assembly, possibly combined with other imported or locally manufactured components, will obviously also be affected. Less direct influences on input prices can occur if local manufacturers, particularly those with protected monopolies, increase selling prices of their products in correspondence with increased prices of imported goods. The direct effects are the most obvious. It can be shown, for example, that a decline of 10 per cent in the exchange rate of the South African Rand will increase local f.o.b. import prices for commodities paid for in other currencies by 11,1 per cent. Import tariffs aggravate such effects. An *ad valorem* import tariff of 10 per cent will for example cause the landed price to increase to 12,2 per cent rather than 11,1 per cent.

Little is known about the effect of exchange rate depreciation on prices paid by farmers. In 1986 the Department of Trade and Industries analysed the effect of exchange rate changes on f.o.b. prices of imported inputs, but it did not concern itself with retail prices (Departement van Handel en Nywerheid, 1986). The Department nevertheless concluded that exchange rate depreciation had been the most important single factor contributing to price increases of imported inputs. In this paper the effect of exchange rate depreciation on retail prices of farm inputs, as well as the time pattern involved, are analysed. It is believed that these analyses will be more relevant than those of the Department of Trade and Industries, since many inputs are combined with components of high local content and since it is the retail price which eventually impacts on the farming sector.

2. Variables included

The effect of exchange rate changes has been determined with respect to the different input categories as classified by the Directorate of Agricultural Economic Trends. A problem may arise in this respect, since the effect of exchange rate changes may differ among items within a category, depending on the extent and origin of imported components.

Some inputs, such as labour, are not acquired from other sectors over the short run. Prices of such inputs do, in general, not react within one year to exchange rate changes (Lindert, 1986). Agricultural wages can be expected to react to wage changes in other sectors rather than to exchange rates as such.

The analyses utilised the effective South African exchange rate on a quarterly basis (1973-1988) as compiled by the South African Reserve Bank. The effective exchange rate and the exchange rate of the Rand with respect to the Belgian Franc, the U.S. Dollar, the French Franc, the German Mark, the British Pound and the Japanese Yen have been shown to be mutually highly correlated (Liebenberg, 1990).

3. Research procedure

Multiple regression analysis was used to quantify relationships between the effective exchange rate and retail prices of agricultural inputs.

These prices are obviously affected by a host of factors other than exchange rates. Thorough structural econometric analyses will be needed to identify all economic entities that materially affect prices of each input category (or Sub-category). In the present study, the focus is however primarily on exchange rate effects. Other factors are regarded as given.

It was hypothesized that some time will lapse before exchange rate changes are fully reflected in selling prices. The effective exchange rate (eff) was therefore included as a lagged exogenous variable. Quarters were used as measurement of time.

Schematically, the model is as follows:

$$Pt = f(eff_t, eff_{t-1}, eff_{t-2}, eff_{t-3}, A) \quad (1)$$

with:

P_t	=	Price of input category in quarter t
eff_t	=	Effective exchange rate, quarter t
eff_{t-1}	=	Effective exchange rate, quarter t-1
eff_{t-2}	=	Effective exchange rate, quarter t-2
eff_{t-3}	=	Effective exchange rate, quarter t-3
A	=	Other factors, taken as a stochastic error term

Observations of prices for input category prices pertain to the first day of each quarter. Corresponding effective exchange rate were compiled by using data to consisting of those referring to the next month and the proceeding two months.

The regression model was as follows:

$$Y = a + b_0 eff_0 + b_1 eff_1 + b_2 eff_2 + b_3 eff_3 \quad (2)$$

with:

Y	= log P_t for input category
eff_0	= log eff_t
eff_1	= log eff_{t-1}
eff_2	= log eff_{t-2}
eff_3	= log eff_{t-3}

Other transformations have also been fitted, but the logarithmic transformation has been chosen for two reasons, one being that the logarithmic transformation generally gave better fits and also, since the main interest was focused on elasticities, the logarithmic form yields constant elasticities which can directly be taken from regression results.

Since the data consist of aggregates - price indices and weighted exchange rate values - statistical problems such as serial correlation, heteroscedasticity and seasonality may cause problems in interpretation of the results.

In order to surmount this problem, attention was initially concentrated on a single input category - tractors (Tro). Regression analysis, utilizing the Statgraphics program, yielded the following results (with t values in parentheses):

$$Tro = 6{,}36 - 1{,}35\, eff_0 - 0{,}17\, eff_1 - 0{,}58\, eff_2 - 0{,}06\, eff_3 \quad (3)$$

$$(27{,}395) \quad (-2{,}154) \quad (-0{,}180) \quad (-0{,}628) \quad (0{,}090)$$

$$F = 86{,}227 \qquad R^2 = 0{,}860 \qquad DW = 0{,}083$$

With the exception of eff_0 which is significant at the 5 percent level, the t values associated with other variables are smaller than 1,0; this indicates very low significance. The low Durbin-Watson value indicates positive serial correlation, which seriously diminishes the reliability of the equation (Wonnacott & Wonnacott, 1979). This problem is addressed in the following section.

4. Removal of serial correlation

The first differences technique (Wonnacott and Wonnacott, 1979) was applied in an effort to eliminate serial correlation where it appears as first order linear serial correlation in the form $U_i = \rho U_{i-1} + V_i$ with $/\rho/<1$. The data are thus transformed by determining the differences between successive observations. This technique has the disadvantage that it assumes that ρ (correlation) equals 1,0 (Pindyck and Rubinfield, 1981). This causes the variance in the error term of the original equation to become infinite (Pindyck and Rubinfield, 1981). If there is a large degree of stability in the data, differences between successive periods become zero, and logarithmic values cannot be used.

Although improved results were obtained with the first differences technique, the disadvantages normally associated with this technique militated against its use. Other alternative techniques tested included the Cochrane-Occutt and Hildreth-Lu procedures, in which the value of ρ is determined (Pindyck and Rubinfield, 1981). This did, however, not result in appreciable improvements in serial correlation as measured by the DW statistic.

An analysis of the error terms revealed the variance in the error term not to be constant. By applying a combination of the Hildreth-Lu procedure and weighted first differences, it was possible to largely cope with the problem of serial correlation.

The model now transformed to:

$$Tr_0^{\bullet} = eff_0^{\bullet} + eff_1^{\bullet} + eff_2^{\bullet} + eff_3^{\bullet} \quad (4)$$

with:

$$Tr_0^{\bullet} = \log\frac{Tr_{0t} - \rho\, Tr_{0t-1}}{Tr_{0t-1}} .100$$

$$eff_0^{\bullet} = \log\frac{eff_{0t} - \rho\, eff_{0t-1}}{eff_{0t-1}} .100$$

$$eff_1^{\bullet} = \log\frac{eff_{1t} - \rho\, eff_{1t-1}}{eff_{1t-1}} .100$$

$$eff_2^{\bullet} = \log\frac{eff_{2t} - \rho\, eff_{2t-1}}{eff_{2t-1}} .100$$

$$eff_3^{\bullet} = \log\frac{eff_{3t} - \rho\, eff_{3t-1}}{eff_{3t-1}} .100$$

In the Hildreth-Lu procedure, the ρ value at which the error sum of square is minimized is selected (Pindyck and Rubinfield, 1981). By fitting ρ with increments of 0,1 from -1,0 to + 1,0, a grid,as shown in Table 1, was constructed.

The value of ρ associated with the smallest error sum of squares was 0,1. Taking ρ as 0,1, the fit was as follows (t values in parentheses):

$$Tro^{\bullet} = 3{,}32 - 0{,}17\, eff_0^{\bullet} - 0{,}33\, eff_1^{\bullet} - 0{,}19\, eff_2^{\bullet} - 0{,}1\, eff_3^{\bullet} \quad (5)$$

$$(23{,}972) \quad (-3{,}120) \quad (-5{,}711) \quad (-3{,}563) \quad (-0{,}738)$$

$$F = 34{,}244 \qquad R^2 = 0{,}6432 \qquad DW = 1{,}718$$

With the exception of eff_3^*, the t values of the coefficients of the independent variables are significant at the 5 per cent level of significance. The F value is significant at the 5 per cent level. There is no more significant serial correlation as measured in accordance with the DW statistic.

Table 1: Grid of ρ with corresponding error sums of squares

ρ	Error sum of squares	ρ	Error sum of squares
- 1	0,0429680	0	0,0154362
-0,9	0,0463798	0,1	0,0098891
-0,8	0,0506752	0,2	0,0100916
-0,7	0,0559826	0,3	0,0138761
-0,6	0,0622158	0,4	0,0212953
-0,5	0,0685225	0,5	0,0341716
-0,4	0,2237782	0,6	0,0573060
-0,3	0,0673612	0,7	0,1032091
-0,2	0,0509047	0,8	Undefined*
-0,1	0,0327637	0,9	Undefined*
		1	Undefined*

* The value of one or more observations was equal to zero before derivation of the log value.

It has thus been demonstrated that in the case of tractors, the selected procedure has succeeded in eliminating significant serial correlation, while at the same time yielding potentially useful results.

5. Regression results

The above procedure above was consequently applied to all the input categories concerned. Forward stepwise regression was employed to estimate coefficients. Selections were consistently carried out at the 5 per cent level of significance. Results concerning statistical significance involving ρ, t, F, R^2 and DW values are presented in Table 2.

It appears that significant serial correlation at the 5 per cent level is still present in one case, namely irrigation equipment. All the F values are significant at the 5 per cent level of significance.

The R^2 values vary from a low of 0,0699 (stock feed) to a high of 0,6432 (tractors). In general, as measured according to R^2, exchange rates generally explain fairly little of the total variation in retail prices of inputs. This could be expected. But its significant effect has been demonstrated by the other measures of significance. For purposes of this research, not much value was attached to R^2 values; the respective F and t values were accepted as measure of significance of the effect of changes in exchange rates.

6. Elasticities

Table 3 presents elasticities of input prices associated with changes in exchange rates.

It appears that exchange rate changes affect tractor price within one quarter, with the remainder of the effect manifesting itself within the next two quarters. A one percent decline or weakening in the effective exchange rate of the Rand in the present, previous and next to previous quarters will in this quarter be associated with tractor price increases of 0,195 percent; 0,328 per cent and 0,167 per cent respectively. An alternative but not dissimilar interpretation is that a one percent drop in the exchange rate will cause a 0,167 per cent rise in tractor prices within the same quarter, followed by another rise of 0,328 per cent in the next quarter, and yet another 0,195 per cent in the third quarter. The total effect is approximately 0,690 per cent.

With no other input category did changes in exchange rate influence retail prices within the same quarter. The input categories showing the highest price elasticities with respect to exchange rates are irrigation equipment, fuel, tractors and packing material. The input groups which appear to be least influenced by exchange rates are fencing and stock feeds.

Virtually no stock feeds or components thereof are imported. The relationship between exchange rate and feed prices can therefore not be regarded as being direct. It must also be borne in mind that the sooner changes in the exchange rate are reflected in retail prices, the more confidence one can have in a direct effect. An effect that manifests itself only after three or four quarters may possibly be caused by other factors such as inflation, general wage levels, etc. These factors are associated with exchange rates without necessarily implying a clear cause-effect direction. Such effects have also been labeled as "third effects" (Tichy, 1976).

The effect of exchange rate on stock feed prices may also partially have been the result of changes in prices of other inputs, such as fuel, fertilizer, railage, etc, which may have shifted feed supply curves to the left; these other input prices have been shown to be influenced by exchange rates.

Table 3: Elasticities of input prices in response to exchange rate changes

Input category	Eff_0^*	Eff_1^*	Eff_2^*	Eff_3^*
Tractors	-0,167	-0,328	-0,195	*
Trucks	*	-0,171	-0,143	*
Implements	*	-0,193	-0,150	*
Irrigation equipment	*	-0,264	-0,444	*
Building	*	-0,201	*	-0,090
Fencing	*	-0,262	*	*
Fertilizer	*	-0,492	*	*
Fuel	*	-0,698	*	*
Stock feeds	*	*	*	-0,204
Sprays and dips	*	-0,368	*	*
Packing	*	*	-0,632	*
Maintenance & Repairs	*	0,171	-0,150	-0,127
Railage/ton of Maize	*	*	-0,408	*

Prices of building materials and fencing are influenced after one quarter, and that of packing material after two quarters. Superficially these influences could also be regarded as being indirect; it has, however been shown that many components of these inputs - for example fertilizer - are imported (Stadler *et al*, 1983). It is also possible that traders in locally manufactured goods can adjust their prices to what they perceive as being psychologically favourable conditions for such business conduct (De Wet *et al*, 1987). Such behaviour can be fairly general under conditions with no or limited competition.

The approximate total elasticity of trucks (approximately -0,314) is much lower than that for tractors, *inter alia* because the trade and manufacturing sectors carry larger stock of particularly small types of trucks than is the case with tractors. Tractors also present a more vital intermediate input in farming, and farmers may hence be in a weaker price bargaining situation where tractor purchases are concerned. Implements on the other hand, are manufactured and supplied by a larger variety of manufacturers and traders; there appears to be more competition in this field. Implements also last longer than tractors. The lower elasticities associated with trucks and implements as compared to tractors appear to be at least partially ascribable to more severe competition. Many implements are also manufactured locally.

Table 2: Measures of significance in transformated lagged variable response

Input category		Exogenous variables Intercept	eff_0^* (t)		eff_1^* (t-1)	eff_2^* (t-2)	eff_3^* (t-3)
Tractors	t	23,9720	-3,1198		-5,7107	-3,5628	**
ρ = 0,1	F			34,4391			
	R^2			0,6432			
	DW			1,718			
Trucks	t	28,6976	**		-4,0536	-3,3397	**
ρ = 0,2	F			23,1123			
	R^2			0,4435			
	DW			2,426			
Implements	t	24,4085	**		-4,4847	-3,4522	**
ρ = 0,2	F			26,7212			
	R^2			0,4796			
	DW			1,7512			
Irrigation equipment	t	11,0955	**		-2,0950	-3,4817	**
ρ = 0	F			10,7971			
	R^2			0,2713			
	DW			1,202			
Building material	t	23,3595	**		-4,9608	-2,1251	**
ρ = 0,2	F			16,7378			
	R^2			0,366			
	DW			2,314			
Fencing	t	16,4739	**		-3,3804	**	**
ρ = 0,2	F			11,4270			
	R^2			0,1623			
	DW			2,269			
Fertilizer	t	10,9352	**		-3,5844	**	**
ρ = 0,1	F			2,8481			
	R^2			0,1788			
	DW			2,214			
Fuel	t	8,9130	**		-3,6415	**	**
ρ = 0,1	F			13,2605			
	R^2			0,1835			
	DW			1,575			
Stock feed	t	12,5202	**		**	**	-2,1064
ρ = 0	F			4,4371			
	R^2			0,0699			
	DW			2,188			
Sprays & Dips	t	11,4079	**		-3,5990	**	-2,3420
ρ = 0	F			9,8959			
	R^2			0,2544			
	DW			2,487			
Packaging	t	12,2986	**		**	-4,7417	**
ρ = 0	F			22,4833			
	R^2			0,2759			
	DW			2,295			
Maintenance and repairs	t	22,4260	**		-3,6262	-3,0011	-2,5873
ρ = 0,1	F			16,5102			
	R^2			0,4649			
	DW			1,656			
Railage	t	12,6400	**		**	-3,6369	**
ρ = 0,1	F			13,2273			
	R^2			0,1968			
	DW			1,766			

** Not significant at 5 per cent level.

The high retail price/exchange rate elasticity of fuel and the medium-high elasticity of railage warrant some comment. These prices have been statutarily and administratively determined.

In the case of fuel, a high percentage of the retail price (not far from 50 per cent) consists of various taxes and levies. The major part of South African fuel is imported and paid for in foreign currency. In the absence of statutory price fixing, fuel prices could have been expected to react quite sharply to any exchange rate depreciation. The analysis shows, however, that statutory agencies which determine prices administratively are no less willing to increase prices in reaction to exogenous occurrences (such as a decline in exchange rates) than are businessmen in industries with relatively little competition. Similar phenomena are discernible in respect of railage. South African rail transport has for over seven decades been the province of a legally protected statutory monopoly. South African Transport Services imports large volumes of goods, including components for diesel and electric equipment. Much of the fuel used on railways is also imported. This alone would lead one to expect railage tariffs to respond to depreciation in exchange rates.

Most of the other input categories rely on rail transport, and increases in railage rates can be expected to have some effect on their prices. This is particularly true with bulky inputs such as building materials, fencing, fertilizer, stock feeds and packing materials.

7. Conclusion

In the analyses presented above, exchange rate changes were isolated from other economic phenomena to ascertain their effects on retail prices of certain classes of inputs to South African agriculture. Lagged response elasticity coefficients varied between -0,090 and -0,698. It can be expected that detailed price structure analyses of the different aggregated input groups and disaggregated specific inputs will yield different elasticities. The elasticities obtained in this study may however be regarded as acceptable. They show that an exchange rate depreciation will not automatically benefit an export product; other factors such as the quantitative importance of exports in the marketing of the product and also its input mix will have important effects. The timing, or (if it is present) seasonality of exchange rate depreciations/ appreciations can obviously also be important, bearing in mind the seasonal timelag in agricultural production.

The analysis involved the period from 1973 to 1988. The South African Rand, has over this period, undergone a substantial net depreciation. It is questionable whether a long-run appreciation of the Rand will result in the same order of elasticities, implying price decreases of inputs. Other factors will have their own role to play. In such a situation, one will however expect inflation rates to be lower; these two variables are closely correlated over the long run. This will obviously affect selling prices of farm inputs.

Another important factor which may influence the impact of exchange rate appreciation is the competitive structure of an input supplying industry. The less the degree of concentration, the larger will be pressures toward lower, or at least intended lower prices when import costs decline. Monopolistic and highly concentrated industries will on the other hand probably not, in terms of selling prices, react to appreciation of the Rand -irrespective of whether monopoly pricing decisions are made by private firms, or whether these prices are administered by a statutory body.

Note

1. This article is based on an MSc (Agric) (Hons) by GF Liebenberg at the University of Pretoria. Financial research assistance by the Institute of Research Development (IRD) of the Human Sciences Research Council (HSRC) is gratefully acknowledged. Opinions expressed in this article are those of the authors and do not necessarily reflect those of the IRD or HSRC.

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