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IMPORTED INFLATION IN SOUTH AFRICA: AN EMPIRICAL STUDY

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Abstract

The main objective of this paper is to analyse the inflationary impact of exchange rate depreciation in South Africa over the period 1984-1998 when the monetary authorities adopted a more market-oriented exchange rate system. Although the empirical part of the paper extensively focuses on this period, the analysis also concentrates on the period 1973-1983 to determine whether the underlying causes of inflation have changed following significant structural, political and institutional changes. From a macroeconomic perspective, the empirical results show that the long-run causes of inflation in South Africa have changed from a demand-pull inflation over the period 1973-1983, to a cost-push cause (import prices and wage rate changes) of inflation since 1987 when a market determined exchange rate finally stabilised.

JEL Classification: C22, E24, E31

Keywords: imported inflation, import pass-through, exchange rate, Phillips curve

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I Introduction

The idea that price inflation is caused by exchange rate depreciation mainly originates from 'structuralist' economists who believe that export earnings in developing countries are generally not enough to finance imported capital and intermediate goods, which play an essential part in their development process (Taylor, 1983; Thirlwall, 1974)[1]. The lack of foreign exchange reserves and the high demand for imported goods, inevitably lead to exchange rate depreciations and a resulting rise in the price of imported goods. The inflationary process will become self-perpetuating when the initial rise in the price of imported goods triggers a wage-price spiral.

The main objective of this paper is to analyse the inflationary impact of exchange rate depreciation in South Africa over the period 1984-1998 when the monetary authorities adopted a more market-oriented exchange rate system[2]. Although the empirical part of the paper will extensively focus on this period, an analysis of imported inflation in the South African economy over the period 1984-1998 will become more consequential when it is compared to the period prior to 1984. The fact that South Africa experienced many structural and political changes over the period 1973-1998, suggests that the underlying causes of inflation have changed. To draw some concrete policy conclusions from the empirical analysis, it is hoped that a direct comparison of the underlying causes of inflation over the

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[1] The shortage of foreign exchange earnings is mainly because many developing countries only export a few primary commodities for which there is a relatively low income elasticity, while the demand for imports has a relatively high income elasticity (Argy, 1970).

[2] For a descriptive analysis of imported inflation during the 1980s in South Africa, see Kantor (1989). Mohr's (1986) theoretical analysis on potential causes of inflation in South Africa, includes a discussion of imported inflation.

sub-periods 1973-1983 and 1984-1998 will illuminate some of the major structural changes that have occurred in the South African economy.

To assess the final, or long-run, inflationary impact of an exchange rate depreciation, two interrelated issues need to be developed in the theoretical and empirical parts of the paper. First, the degree of import pass-through that results from an exchange rate depreciation – i.e. to what degree will an exchange rate depreciation be reflected in the price of imported goods? Second, to what extent will the initial rise in import prices trigger a wage-price spiral?

The plan of the paper is as follows. Section II develops a simple wage and price model to determine the wage-price spiral that results from a shock to import prices. Section III sets out a theoretical import price equation to determine the magnitude of an exchange rate depreciation on import prices, i.e. the degree of import pass-through. Section IV presents a brief overview of some of the key macroeconomic features that characterised the South African economy over the sub-periods 1973-1983 and 1984-1998. Based on the different sub-periods identified in section IV, empirical results for the wage-price models and the import price equation are presented in section V. Section VI incorporates the estimation results into one model to assess the long-run impact of an exchange rate depreciation on price inflation. Section VII ends with some summary remarks and policy implications.

II A simple wage and price model for the South African economy

The wage and price models in this section mainly originate from Lipsey and Parkin's (1970) theoretical analysis. Goldstein (1974) also adopted similar wage and price equations to analyse the inflationary impact of exchange rate devaluations in the United Kingdom. More recent studies have made some modifications to the basic price equation in an attempt to study

a Phillips curve type relationship in a price, rather than a wage, equation (Clark *et al*., 1996; Filardo, 1998).

Consider the following price equation in its distributed lag form:

$$\dot{p}_t = \beta_0 + \sum_{i=0}^{j} \beta_{1i} \dot{w}_{t-i} + \sum_{i=0}^{k} \beta_{2i} \dot{e}D_{t-i} + \sum_{i=0}^{l} \beta_{3i} \dot{q}_{t-i} + \sum_{i=0}^{m} \beta_{4i} i\dot{m}p_{t-i} + \varepsilon_t, \qquad (1)$$

which yields the following long-run solution:

$$\dot{p} = \lambda_0 + \lambda_1 \dot{w} + \lambda_2 \dot{e}D + \lambda_3 \dot{q} + \lambda_4 i\dot{m}p; \quad \lambda_1 > 0,\ \lambda_2 > 0,\ \lambda_3 < 0,\ \lambda_4 > 0, \qquad (2)$$

where all the variables are in rates of change and $\dot{p}$ is consumer price inflation. The λ's are, respectively, the long-run estimates of the intercept (λ_0); the wage rate in the private sector ($\dot{w}$); 'excess' demand or output gap ($\dot{e}D$); labour productivity ($\dot{q}$); and import prices ($i\dot{m}p$).

Although the relationship between price inflation and 'excess' demand mainly describes a pure demand-pull model of inflation, it can also be analysed as a Phillips curve type relation if it is assumed that pressure in the product market is a good proxy for pressure in the labour market. The 'excess' demand variable is defined as the actual real GDP rate of change ($\dot{y}$) minus the rate of change of potential output ($\bar{\dot{y}}$). The rate of change of potential output is measured as a centred-moving average filter[3]:

$$\bar{\dot{y}} = \frac{1}{2k+1}[\dot{y}_t + \sum_{i=1}^{k} (\dot{y}_{t+i} + \dot{y}_{t-i})], \qquad (3)$$

[3] In many empirical studies the 'excess' demand variable is defined as the *level* of actual output minus the *level* of potential output (or trend) (e.g. Laxton *et al*., 1995). The trend or potential output is then measured by the Hodrick Prescott (H-P) filter or, similarly, a centred-moving average filter. These techniques have been criticised on the basis that the H-P filter acts as a smoother over most of the sample period (Razzak, 1997), while Harvey and Jaeger (1993) show that simple filters may induce spurious regressions. In the empirical section simple filters constructed from level variables yielded poor results. Based on Gordon's (1997) suggestion, 'excess' demand is rather constructed as a rate of change variable.

where $k = 8$[4]. By adopting a simple filter measure, data in the empirical section are utilised from 1971 quarter one until the fourth quarter in 1998, so that the sample period effectively stretches from 1973q1 until 1996q4.

The wage equation in its auto regressive distributed lag form is given by:

$$\dot{w}_t = \alpha_0 + \sum_{i=1}^{r} \alpha_{1i} \dot{w}_{t-i} + \sum_{i=1}^{s} \alpha_{2i} \dot{p}_{t-i} + \xi_t, \tag{4}$$

where the variables are defined as before. Equation (4) captures wage inertia and the wage formation process of wage earners which is based on price inflation in the past and current periods. The long-run solution of equation (4) reflects a relation between wages and inflation expectations ($\dot{p}^e$)[5]:

$$\dot{w}_t = \delta_0 + \delta_1 \dot{p}_t^e, \quad \delta_1 > 0, \tag{5}$$

where the δ 's are the long-run parameter estimates.

Finally, to capture the impact of the wage-price spiral on long-run equilibrium price inflation and assuming that $\dot{p}^e$ is a proxy for $\dot{p}$, substitute equation (5) into equation (2) to obtain the following reduced form equation:

$$\dot{p} = \frac{\sigma_0 + \lambda_2 \dot{e}D + \lambda_3 \dot{q} + \lambda_4 i\dot{m}p}{(1 - \lambda_1 \delta_1)}, \tag{6}$$

where σ_0 is the intercept term $(= \lambda_0 + \lambda_1 \delta_0)$. From equation (6) it can be seen that the inflation rate will become more explosive the closer the wage-price spiral $(\lambda_1 \delta_1)$ is to one. If

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[4] The value of *k* was determined by experimenting with different values in the empirical section of the paper, and then choosing the value which was most consistent with a Phillips curve relation.

[5] Inflation expectations models such as equation (5) have been criticised on the grounds that the model is only backward looking and excludes forward looking wage setters (Debelle and Laxton, 1997). However, despite the lack of inflation survey data over an extended period in South Africa, the major structural and institutional changes that have occurred over the period 1973-1998 suggest that an analysis of inflation expectations should first be based on a more simple approach, rather than the more sophisticated methods that have been employed in developed countries.

the wage-price spiral is equal to one ($\lambda_1\delta_1 = 1$), then there is no long-run solution to equation (6) and the trade-off between price inflation and 'excess' demand disappears. Thus, the expectations augmented view of the Phillips curve held by Friedman (1968) and Phelps (1968) depicts a vertical long-run Phillips curve if the wage-price spiral is equal to one. In the long-run, inflation is non-accelerating with actual inflation equal to expected inflation ($\dot{p}_t = \dot{p}_t^e$).

III Import pass-through

The import price coefficient λ_4 in equation (6) captures the inflationary impact of all the exogenous shocks to import prices. To specifically determine the long-run impact of an exchange rate depreciation on price inflation, an estimate of the degree of import pass-through is required. Import pass-through can be described as the degree to which exchange rate changes are reflected in the destination currency prices of imported goods (Menon, 1993). The higher the degree of import pass-through, the higher the long-run impact on price inflation following an exchange rate change.

III.i Import price equation

Based on the elasticities approach, the measurement of the degree of import pass-through (*P*) can be expressed in the following way (Branson, 1972):

$$(\partial P_D / \partial exr) = (1 - \varepsilon_D / \varepsilon_S)^{-1} = P\,, \tag{7}$$

where P_D is the domestic currency price of the imported good, *exr* is the exchange rate (the foreign currency price of domestic currency), ε_D is the elasticity of the demand for imports and ε_S is the supply elasticity of imports. Equation (7) shows that the percentage change in

the domestic currency price of the imported good following an exchange rate change is a function of the demand and supply elasticities (Menon, 1995a).

From equation (7) it can be seen that the degree of import pass-through will be higher the lower is the elasticity of demand and the higher the elasticity of supply. From a theoretical point of view, it is expected that the degree of import pass-through will be complete for a small open economy which is a price taker in world markets. In such a case, foreign suppliers will leave their foreign prices unchanged following an exchange rate depreciation, so that the exchange rate change is proportionately reflected in the domestic currency price of the imported good.

Alternatively, the degree of import pass-through can also be measured in an import price equation (Dwyer *et al*., 1994; Dwyer and Lam, 1995; Hooper and Mann, 1989; Menon, 1996). As a starting point, first consider the 'law of one price'. The law states that the price of a traded good (in this case an imported good) will be the same in both domestic and foreign countries when the imported good is expressed in a common currency. The following expression captures this relation:

$$imp = imp^{*}.exr\ , \tag{8}$$

where *imp* is the price of the imported good, imp^{*} is the corresponding foreign price and *exr* is the exchange rate denoted in units of domestic currency per unit of foreign currency (an increase in *exr* indicates a depreciation). For a given foreign price, the law of one price will fail to hold when changes in the price of the domestic imported good are not proportional to changes in the exchange rate. If this is the case, then import pass-through following an exchange rate change is incomplete.

To estimate the long-run import pass-through relationship, equation (8) is transformed into a log-linear model which allows for a constant:

$$Limp_t = \alpha_0 + \alpha_1 Lexr_t + \alpha_2 Lppi_t; \quad \alpha_1 > 0, \ \alpha_2 > 0, \tag{9}$$

where $Limp_t$ is an aggregate import price deflator;

$Lexr_t$ is the nominal exchange rate measured as a trade weighted index, with weights proportional to the import shares of South Africa's major suppliers[6];

$Lppi_t$ is the producer price index (a proxy for foreign prices) of South Africa's major suppliers weighted in the same way as $Lexr_t$. (Data source: OECD Statistical Compendium, 1997).

In many empirical studies it is common practice to use an import weighted export price index as a proxy for foreign prices. The major problem with this index is that it represents the pricing decision on exports to all markets (Menon, 1995b). The export price index may therefore not accurately reflect the supply price of exports to South Africa if there are different pricing-to-market strategies. Alternatively, as suggested by Menon (1996), an import-weighted cost of production index (producer price index) is used for South Africa which is unaffected by the pricing-to-market problem.

The long-run import pass-through relationship in equation (9) implies an important cross coefficient restriction to assess the theoretical and empirical validity of the model. Irrespective of whether import pass-through in South Africa is complete or not, the model implies that the exchange rate and producer price index coefficients should be equal in magnitude, i.e. $\alpha_1 = \alpha_2$.

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[6] South Africa's major suppliers include the United States, the United Kingdom, Japan, Germany, France, Italy and the Netherlands. The import weights were constructed from International Monetary Fund, Direction of Trade Statistics (various issues).

III.ii Incomplete import pass-through in a small open economy: some theoretical considerations

In an extensive survey of the exchange rate pass-through literature, Menon (1995a) shows that small open economies have received little attention in the literature, although the existing studies indicate that import pass-through has generally been incomplete. Based on the empirical evidence for a wide range of countries, Menon (1995a, 1996) identifies various theoretical reasons why import pass-through may be incomplete even in a small open economy. Moreover, the elasticities approach in equation (7) can only give an accurate proxy for import pass-through in the absence of shocks. In an environment where macro and micro economic conditions dictate the degree of import pass-through, an import price equation such as (9) will give a more accurate and reliable estimate of the pass-through coefficient.

In a macroeconomic environment where domestic demand is buoyant, the degree of import pass-through is likely to be high irrespective of the demand and supply elasticities. Similarly, when domestic demand is low foreign suppliers may squeeze their profits to protect their market share. In this case, import pass-through is incomplete and may again not be captured accurately by the elasticities approach.

From a microeconomic perspective, import pass-through will be complete in a perfectly competitive environment where foreign and domestic goods are perfect substitutes, i.e. the law of one price in equation (8) will hold[7]. By contrast, in an imperfectly competitive environment the degree of import pass-through will depend on the degree of substitutability between the domestic competing good and the imported good, as well as the degree of market integration. The lower the degree of substitutability and the lower the degree of market integration, the higher the market power of sellers. When the degree of substitutability is low,

[7] Webber (1995) presents a theoretical analysis to determine the sensitivity of pass-through to the microeconomic environment.

foreign suppliers have some leverage to dictate the market price of their traded good. If foreign suppliers are profit maximisers, then import pass-through will inevitably be high, while the degree of pass-through will be lower when agents seek to maximise their market share. With a low degree of market integration, some discrimination may occur between different markets. The pricing-to-market rule will then lead to different degrees of pass-through across segmented markets.

In addition to micro and macro considerations, there are several other reasons why import pass-through may be incomplete (Menon, 1995a, pp.204-207). Among others, these include multinational corporations who employ intra-firm pricing policies to absorb some of the impact of exchange rate changes, and the existence of non-tariff barriers which reduces the premium on imports after an exchange rate depreciation, rather than increasing its price.

III.iii The long-run inflationary impact of an exchange rate depreciation

From equation (6), the long-run inflationary impact of an increase in import prices and the subsequent wage-price spiral that it triggers can be written as[8]:

$$\frac{\partial \dot{p}_t}{\partial \dot{imp}_t} = \frac{\lambda_4}{(1-\lambda_1\delta_1)} \tag{10}$$

The import pass-through equation expressed in rates of change is given by:

$$\dot{imp}_t = K(\dot{exr}_t + \dot{pi}_t)\,. \tag{11}$$

Differentiating equation (11) with respect to $\dot{exr}$ yields:

$$\frac{\partial \dot{imp}_t}{\partial \dot{exr}_t} = K\,, \tag{12}$$

[8] The theoretical exposition in this section draws largely on Goldstein (1974).

where *K* is the import pass-through estimate. The long-run inflationary impact of an exchange rate depreciation will depend on the degree of import pass-through and the wage-price spiral as in equation (13):

$$\frac{\partial \dot{p}_t}{\partial e\dot{x}r_t} = \frac{\partial \dot{p}_t}{\partial i\dot{m}p_t} \cdot \frac{\partial i\dot{m}p_t}{\partial e\dot{x}r_t} \tag{13}$$

Substituting (10) and (12) into (13) gives:

$$\frac{\partial \dot{p}_t}{\partial e\dot{x}r_t} = \frac{\lambda_4}{(1-\lambda_1\delta_1)} K \tag{14}$$

IV Macroeconomic features of the South African economy, 1973-1998

From the theoretical models outlined in the previous sections it is clear that wages, prices, the exchange rate and import prices are all inextricably linked, so that instability in one variable will invariably have a ripple effect on all the others. Since the main objective of this paper is to analyse the inflationary impact of exchange rate depreciations over the period 1984-1998 when the exchange rate was more market-oriented, it is important to provide some descriptive evidence to determine whether the relevant variables under analysis are stable. It is also envisaged that significant structural, political and institutional changes over the period 1973-1998 have played a major role in changing the underlying causes of inflation over the sub-periods 1973-1983 and 1984-1998.

Figure I displays plots in annualised quarterly rates of change for price inflation (*Infl*), unit labour costs (*Unit*) and 'excess' demand (*eD*) over the period 1973-1998[9].

[Figure I]

[9] Unless stated otherwise, all the data in this paper are quarterly and obtained from the South African Reserve Bank's historical data set published on the internet (http://www.resbank.co.za/Economics/econ.html).

During the sub-period 1973-1983, it can be seen that the rate of change of unit labour costs consistently exceeded price inflation, especially during the early 1970s and early 1980s. These features could be the result of the oil price shock in 1973-1974 and exchange rate devaluations during the early 1970s which increased South Africa's inflation rate from an annual rate of around 2.5% during the 1960s to double digit figures since the early 1970s[10]; nominal wage increases following the sharp increase in the gold price in 1979; and the legalisation of Black trade unions in 1980. By contrast, over the period 1984-1998 there seems to be a much closer and stable relation between unit labour cost and price inflation. The 'excess' demand variable displays cyclical fluctuations from 1973 until the mid-1980s, but thereafter seems to fade away considerably.

Figure II depicts the relation between the annualised quarterly rates of change of import prices (imp) and exchange rate, and the level of import prices (*Limp*) and exchange rate (*Lexr*)[11].

[Figure II]

From 1973 until 1978 the monetary authorities adopted a fixed exchange rate system which pegged the rand to the US dollar. In 1979, a policy of variable dollar pegging was adopted which led to a more market-oriented exchange rate system. Towards the end of 1983, the Reserve Bank ceased to quote the spot exchange rate and allowed the exchange rate to be determined directly by the market (Kahn and Parikh, 1998). Furthermore, the exchange rate was subjected to a high degree of variability when capital controls on non-residents were abolished in 1983, but subsequently reinstated in 1985.

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[10] Strydom and Steenkamp (1976) showed that successive exchange rate devaluations during the early 1970s increased import prices, which subsequently led to a sharp increase in price inflation.

[11] The exchange rate is a trade-weighted index (exports plus imports) and is denoted in units of foreign currency per unit of domestic currency, so that a decrease is a depreciation.

The significant changes in the exchange rate system are captured in Figure II. From 1973-1983 the exchange rate in levels and rates of change remained fairly stable. The ability of the Reserve Bank to maintain a fixed exchange rate system (albeit to different degrees) over this period, was mainly supported by substantial capital inflows and a high gold price. After 1983 the drop in the dollar gold price, substantial capital outflows following increased political instability and the immediate repayment of foreign debt in 1985, were all factors that contributed to a depreciating exchange rate. It is also noticeable that after the adoption of a market determined exchange rate in 1983, both the level and rate of change of the exchange rate showed a greater degree of stability from 1987 onwards.

From the brief descriptive analysis it is clear that a structuralist theory of imported inflation may not necessarily be a characteristic feature of the South African economy over the period 1973-1983 when the exchange rate was fixed, but only after 1983 when the monetary authorities adopted a more market-oriented exchange rate sytem. Figure II shows a relatively stable relation between the rate of change of import prices and the exchange rate from the mid-1980s, while this relation is less conspicuous over the period of a fixed exchange rate system. During the early 1970s, variations in import prices seem to be the result of external shocks, rather than exchange rate movements. Based on the descriptive evidence, the empirical part of this paper will focus on three different sub-periods using quarterly data: 1973-1983, 1984-1998 and 1987-1998.

V Empirical results

V.i Price and wage equations

The price and wage equations are all estimated in annualised quarterly rates of change over the period 1973-1998. Distributed lag (DL) and Auto Regressive Distributed Lag

(ARDL) models are first estimated for the price and wage equations respectively (equations 1 and 4), and the corresponding long-run solutions are reported in Table I and Table II. The lag structures are determined by starting from general models with lag structures of up to order seven, and then eliminating insignificant lags to obtain the most parsimonious model. The price and wage equations pass all the diagnostic tests in the different sub-periods at the 5% significance level.[12] In all the price equations only the lagged values of the wage rate yielded significant results, which imply that the model is recursive. The standard OLS method may therefore be applied to estimate the parameters of the wage-price equations separately.

Table I reports the long-run results for the price equations over the different sub-periods.

[Table I]

Equations (15) and (16) are almost identical except that the insignificant labour productivity variable is dropped from equation (16). Three noteworthy features stand out in the price equations over the period 1973-1983. First, the import price coefficient is very low, and second, the 'excess' demand variable is statistically significant with a high coefficient of 0.52. Third, as is shown in Figure I, the wage rate has a relatively low coefficient. In contrast, price equation (17) over the period 1984-1996 yields a significant labour productivity coefficient and an insignificant 'excess' demand coefficient. More importantly, the import price coefficient is significant at the 1% level and much higher in magnitude compared to the period 1973-1983. Equation (18) excludes 'excess' demand and extends the sample period to 1998. The main difference between this equation and the preceding ones is the much higher magnitude of the wage coefficient. Finally, equation (19) estimates the price equation over the

[12] Structural stability tests were based on the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests of the recursive residuals, which showed that all the models identified over the sub-periods display structural stability at the 5% significance level.

sub-period 1987-1998. As predicted by Figure I, the wage and the import price coefficients are both high in magnitude compared to the sub-period 1973-1983.

The long-run wage equations are given in Table II.

[Table II]

Price expectations in equation (20) yield an extremely high coefficient of 1.52 over the period 1973-1983. However, it is important to note from Figure I that the wage rate outpaced price inflation, so that, effectively, the wage-price spiral derived from equation (6) is very low ($\lambda_1\delta_1 = 0.15\times1.52 = 0.23$). Over the sub-periods 1984-1998 and 1987-1998 the price expectations coefficient in the wage equation is considerably lower and more in line with the impact of wages on prices. More specifically, the wage coefficient in equation (19) and the inflation expectations coefficient in equation (22) are almost identical in magnitude over the period 1987-1998, which implies that the wage-price spiral stabilised after the move towards a more market determined exchange rate. Effectively, the wage-price spiral derived from equation (6) of ($0.73\times0.79 =$) 0.58 is much higher over the period 1987-1998.

In sum, the evidence thus far suggests that the underlying causes of inflation have changed between the sub-periods 1973-1983 and 1984-1998. The analysis further suggests that the long-run inflationary effect of an exchange rate depreciation is particularly relevant over the period 1987-1998 when all the relevant variables seem to have stabilised.

V.ii Import price equations

To assess whether the long-run import price equations yield robust estimates of the import pass-through coefficient, equations in levels and rates of change will be considered. First, consider the import price equation in levels given by (9). Standard Dickey Fuller (DF)

and Augmented Dickey Fuller (ADF) tests statistics over the period 1984q1-1997q1 showed that all the variables in levels contain a unit root, but are stationary in first differences[13].

Table III reports cointegration tests and long-run estimates of equation (9) based on the maximum likelihood systems procedure developed by Johansen and Juselius (1990). Panel A shows that the null hypothesis of no cointegration can be rejected at the 5% significance level over the period 1984q1-1997q1.

[Table III]

Panel A(i) gives the long-run elasticities and panel A(ii) tests the cross coefficient restriction implied by equation (9). From panel A(ii) it can be seen that the cross coefficient restriction is marginally rejected at the 5% significance level. The result may suggest that a long-run analysis of import pass-through should focus on the period 1987q1-1997q1, when the exchange rate stabilised after the move towards a more market determined system.

Panel B tests for cointegration over the period 1987q1-1997q1and shows that the null hypothesis of no cointegration can be rejected at the 5% significance level. Panel B(i) reports the long-run elasticities and panel B(ii) tests the cross coefficient restriction. In contrast to the sub-period 1984q1-1997q1, the null hypothesis cannot be rejected. In addition, panel B(ii) tests whether the import pass-through coefficient is insignificantly different from unity, and shows that this restriction can be rejected at the 1% significance level. Panel B(iii) reports the long-run elasticities when the cross coefficient restriction is imposed. Based on the results in panel B(ii), the long-run elasticity of 0.82 in panel B(iii) is significantly different from one, i.e. import pass-through is incomplete in South Africa.

[13] The import price equations are only estimated until the first quarter of 1997. Data obtained from the OECD's statistical compendium for producer prices only cover this period.

The long-run solution of an underlying ARDL model estimated in annualised quarterly rates of change over the period 1987q1-1997q1 is given by (absolute *t*-statistics in parentheses)[14]:

$$\dot{imp} = \underset{(0.12)}{-0.20} + \underset{(5.21)}{0.83}\dot{exr} + \underset{(3.74)}{0.60}\dot{ppi} \qquad (23)$$

$R^2 = 0.83$
LM-test (serial correlation): F(4,24) = 0.41
Functional form: F(1,27) = 0.05
Normality: $\chi^2(2) = 0.08$
Heteroscedasticity: F(1,39) = 0.10

Long-run test: F-test = 6.67
Wald test: $\chi^2(1) = 0.86$
(cross coefficient restriction)

Equation (23) is well determined and comfortably passes all the diagnostic tests. The long-run F-test based on Pesaran *et al's* (1996) unrestricted error correction procedure for I(0) variables, shows that the null of no long-run relationship between import prices, the exchange rate and producer prices can be rejected at the 1% significance level; conditional on the exchange rate and producer prices as the long-run 'forcing' variables for import prices. The Wald test reported below equation (23) indicates that the cross coefficient restriction cannot be rejected. Equation (24) gives the long-run model when the cross coefficient restriction is imposed (absolute *t*-statistics in parentheses):

$$\dot{imp} = \underset{(0.42)}{0.58} + \underset{(7.27)}{0.72}\dot{exr} + \underset{(7.27)}{0.72}\dot{ppi} \qquad (24)$$

In addition, to test the null hypothesis that the import pass-through coefficient of 0.72 is insignificantly different from unity, the Wald test of 7.79 indicates that this restriction can be rejected at the 1% significance level.

[14] The optimal lag length in the ARDL model was again determined by starting form a general model with a lag length of order seven, and then eliminating lags with insignificant parameter estimates.

To summarise, both the levels and rates of change estimates are close in magnitude and further provide evidence that import pass-through is incomplete in South Africa. The results also support the prior belief that the long-run inflationary impact of an exchange rate change should be investigated over the period 1987q1-1998q4, when a more market determined exchange rate finally stabilised.

VI The long-run inflationary impact of an exchange rate depreciation

To investigate the long-run inflationary impact of an exchange rate depreciation and the subsequent wage-price spiral that it triggers over the period 1987-1998, the values from equations (19), (22) and (24) are substituted into equation (14).

$$\frac{\lambda_4}{(1-\lambda_1\delta_1)}K = \frac{0.35}{[1-(0.79)(0.73)]} \times 0.72 = 0.60 \qquad (25)$$

Equation (25) states that a one percent depreciation in the exchange rate over the period 1987-1998, will (on average) lead to a 0.60 percent increase in price inflation. To supplement the evidence in equation (25), the generalised impulse response analysis described by Pesaran and Shin (1998) can be employed to show the impact on price inflation (*Infl*), unit labour cost (*Unit*) and import prices (*imp*) following an exogenous shock to the exchange rate over the period 1987-1998[15]. Figure III displays the effect of a one standard error shock to the import weighted exchange rate over a time horizon of thirty quarters.

[Figure III]

[15] The analysis is first based on estimating an unrestricted Vector Auto Regressive (VAR) model which includes price inflation, unit labour cost, the import weighted exchange rate and import prices. The generalised impulse response functions can then be estimated with respect to a one standard error shock to the exchange rate. Based on the Akaike and Schwartz Bayesian criteria an unrestricted VAR model of order five is estimated.

Figure III shows that price inflation, unit labour cost and import prices all show a high degree of persistence over a long period of thirty quarters. The analysis is particularly useful for policy purposes, since it reiterates that exchange rate depreciations over the period 1987-1998 provide a long-run explanation of price inflation in South Africa.

Finally, to capture the significant changes in the underlying causes of inflation between the sub-periods 1973-1983 and 1987-1998, we substitute the values from equations (16), (19), (20) and (22) into equation (6)[16]. The most striking feature of the results in Table IV is that the underlying causes of inflation in South Africa have changed from a demand-pull inflation over the period 1973-1983 to a cost-push cause of inflation over the period 1987-1998.

[Table IV]

The significant impact of labour productivity over the period 1987-1998, could be the direct result of escalating labour unrest during the 1980s and 1990s following the legalisation of Black trade unions in 1980 (Sadie, 1992). This is borne out by the wage-price spiral coefficient which increased from 0.23 over the period 1973-1983 to 0.58 over the period 1987-1998.

Even if it assumed that import pass-through is complete over the period 1973-1983, the low magnitude of the import price coefficient again underlines the fact that import prices do not provide a long-run explanation of price inflation over this period. During different times, a rise in import prices has been inflationary following exchange rate devaluations and a once-off adverse supply shock. However, capital inflows and a high gold price during this period

[16] A direct comparison between the sub-periods 1973-1983 and 1987-1998 is strictly speaking only valid based on a precondition. Since the 'excess' demand variable is constructed as a centred-moving average filter, equations in Table I which include this variable are only estimated until the fourth quarter of 1996. From a long-run perspective, the 'excess' demand variable is therefore excluded from equation (19) under the assumption that the insignificance of 'excess' demand since the mid-1980s also holds until the fourth quarter of 1998.

allowed the monetary authorities to maintain a fixed exchange rate, which prevented continuous devaluations.

By contrast, the high magnitude of the import price coefficient over the period 1987-1998 not only reflects the move towards a market determined exchange rate system, but also the undiversified nature of South Africa's export sector[17]. Evidently, a structuralist theory of price inflation becomes relevant over the period 1987-1998. The general decline in the mining sector coupled with substantial capital outflows have led to a steady, but depreciating exchange rate, which have made the South African economy extremely vulnerable to imported inflation.

VII Conclusions and policy implications

The main findings of this paper have shown that the long-run causes of inflation in South Africa have changed from demand-pull inflation in 1973-1983, to a cost-push cause of inflation (import prices and wage rate changes) in 1987-1998. Cost-push inflation became more relevant in the South African economy after 1983, when substantial capital outflows, the general decline in the mining sector and an undiversified export sector exposed the country to imported inflation.

During the 1980s and 1990s, more restrictive monetary policy measures were in place to protect the country's balance of payments from adverse political and economic conditions (Botha, 1997; De Wet, 1995; Schmulow and Greyling, 1996). To maintain price stability, restrictive monetary policy measures were mainly based on reducing domestic aggregate demand. Although the successful democratic election in 1994 witnessed South Africa's

[17] Fallon and de Silva (1994) provide a thorough analysis of South Africa's export sector.

reintegration into the global economy and the return of capital flows, macroeconomic policy up to the present is still based on restrictive measures (Weeks, 1999)[18]. To this end, the monetary authorities succeeded in bringing the inflation rate down gradually from double digit rates of around 13 percent per annum over the period 1973-1993, to single digit rates of around 7.7 percent per annum over the period 1994-1998.

The insignificant inflationary impact of 'excess' demand over the period 1984-1996 in this study may, to some extent, capture the impact of restrictive monetary policy measures. Although there are various microeconomic reasons to explain incomplete pass-through, low domestic demand seems to be particularly relevant to explain why the degree of import-pass through is incomplete in a small open economy like South Africa. The long-run pass-through estimates of 72% and 82% in rates of change and levels respectively, also compare favourably with the pass-through estimates reported for other small open economies. For manufacturers import prices in Australia, Menon (1995b) reports an import pass-through estimate of 65%, while Moreno's (1989) import pass-through estimates range between 58% for Korea and 74% for Taiwan.

The main policy implication of this study is that restrictive demand management policies may not necessarily promote high and sustainable economic growth, even though the monetary authorities managed to bring the inflation rate down to single digit rates[19]. The underlying cause of inflation is not demand-pull but cost-push. As long as the present structural features of the South African economy remain the same, there will always be a bias

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[18] Once the ANC government came into power in 1994, the proposed GEAR (Growth, Employment, and Redistribution programme) policy document stipulated an orthodox macroeconomic programme of tight fiscal and monetary policy, combined with trade liberalisation (Weeks, 1999).

[19] The underlying motive for restrictive macroeconomic policy measures in the GEAR programme is to achieve the twin objectives of high growth and low inflation. According to Weeks (1999), however, growth has remained far below the target stipulated in GEAR.

towards inflation. Against the background of an unemployment rate which has recently reached an unprecedented high of 40 percent, the time has come to consider whether the benefits reaped from lower unemployment outweigh the costs of higher inflation.

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Figure I

Inflation, unit labour cost and 'excess' demand over the period 1973q1-1998q4

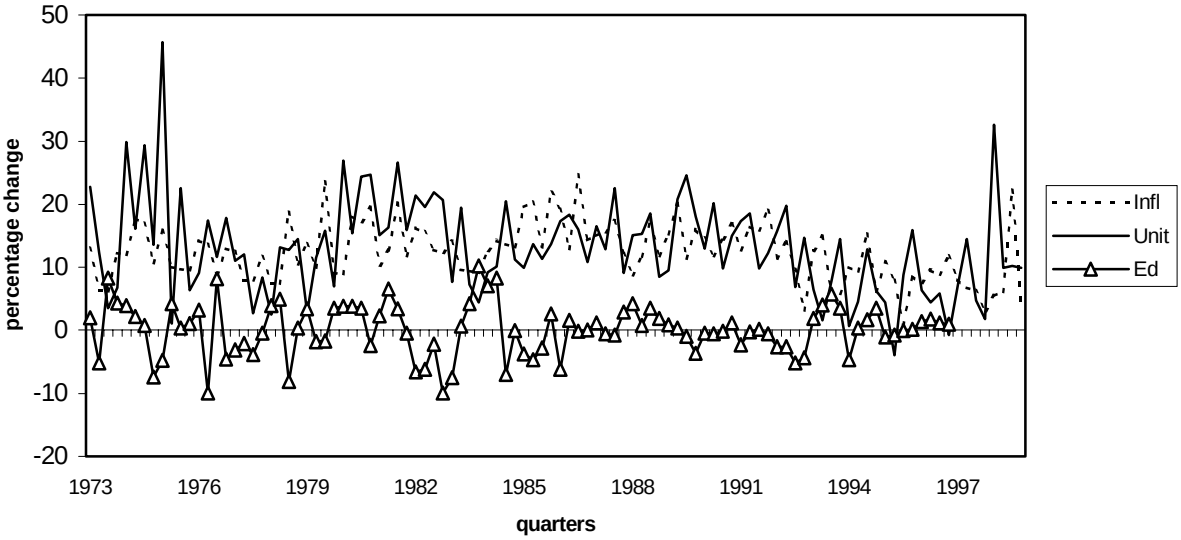

Figure II

Exchange rate and import prices over the period 1973q1-1998q4

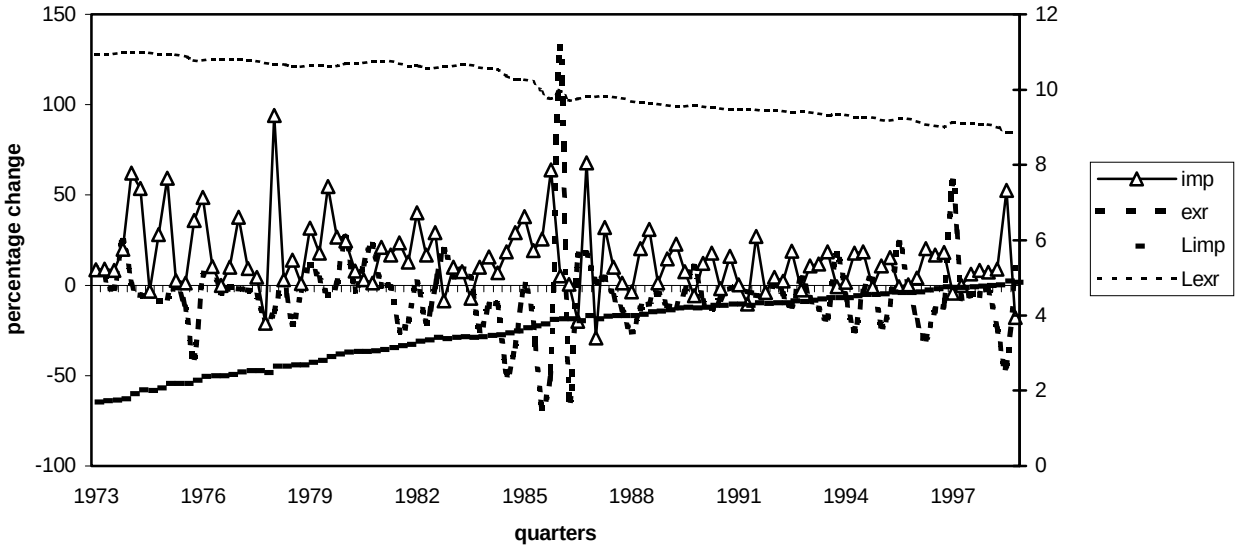

Figure III

Generalised impulse response analysis

(based on an unrestricted VAR model over the period 1987q1-1998q4)

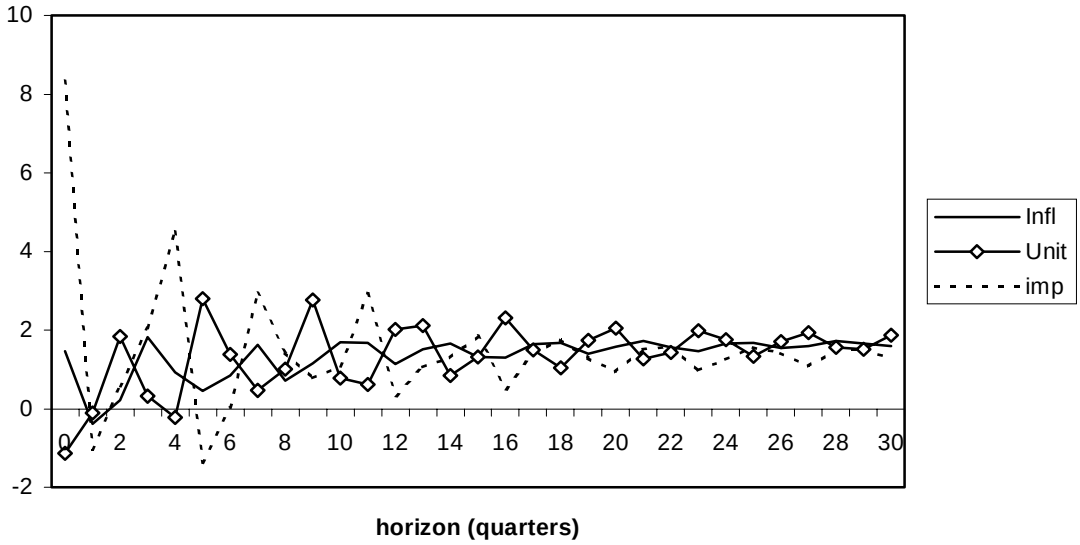

Table I

Long-run price equations for the period 1973q1-1998q4

VARIABLES	EQN 15 73Q1-83Q4	EQN 16 73Q1-83Q4	EQN 17 84Q1-96Q4	EQN 18 84Q1-98Q4	EQN 19 87Q1-98Q4
Intercept	8.99*** (6.76)	8.75*** (6.60)	8.58*** (3.65)	6.25*** (3.14)	-1.65 (-0.68)
$\dot{w}_t$	0.15* (1.91)	0.15* (1.91)	0.27* (1.83)	0.41*** (3.23)	0.79*** (5.47)
$\dot{e}D_t$	0.50*** (2.98)	0.52*** (3.11)	0.17 (0.82)		
$\dot{q}_t$	-0.15 (-1.23)		-0.93*** (-3.54)	-0.91*** (-4.26)	-0.37** (-2.63)
$i\dot{m}p_t$	0.07* (1.78)	0.08** (2.06)	0.20*** (3.31)	0.22*** (3.78)	0.35*** (3.42)
Diagnostic tests					
R^2	0.34	0.31	0.50	0.55	0.66
LM-test	F(4,33) = 0.64	F(4,34) = 0.54	F(4,37) = 1.23	F(4,47) = 1.93	F(4,34) = 0.82
Ramsey's Reset	F(1,36) = 0.42	F(1,37) = 0.24	F(1,40) = 0.62	F(1,50) = 0.00	F(1,37) = 0.31
Normality	$\chi^2(2) = 0.83$	$\chi^2(2) = 0.23$	$\chi^2(2) = 1.96$	$\chi^2(2) = 0.91$	$\chi^2(2) = 0.08$
Heteroscedasticity	F(1,42) = 2.35	F(1,42) = 3.73	F(1,50) = 0.37	F(1,42) = 0.15	F(1,46) = 0.02

Notes:
1. *t*-statistics are in parentheses.
2. *** denotes significance at the 1% level, ** at the 5% level and * at the 10% level.

Table II

Long-run wage equations for the period 1973q1-1998q4

VARIABLES	EQN 20 73Q1-83Q4	EQN 21 84Q1-98Q4	EQN 22 87Q1-98Q4
Intercept	-3.43 (-0.93)	4.61 (1.42)	4.54 (1.45)
p_t^e	1.52*** (5.19)	0.69*** (2.79)	0.73*** (2.94)
Diagnostic tests			
R^2	0.45	0.40	0.41
LM-test	F(4,32) = 1.39	F(4,48) = 0.46	F(4,38) = 0.92
Ramsey's Reset	F(1,35) = 0.22	F(1,51) = 0.30	F(1,41) = 0.35
Normality	$\chi^2(2) = 0.25$	$\chi^2(2) = 1.39$	$\chi^2(2) = 0.66$
Heteroscedasticity	F(1,42) = 3.45	F(1,58) = 0.11	F(1,46) = 0.02

Notes:
See Table I

Table III

Import pass-through estimates (levels) based on the Johansen procedure

Panel A: Tests for cointegration between *Limp*, *Lexr* and *Lppi*: 1984q1-1997q1		
H_0	λ max eigenvalue	λ trace
r = 0	24.07**	37.98**
r ≤ 1	10.33	13.90
r ≤ 2	3.57	3.57
Panel A(i): Long-run elasticities over the period 1984q1-1997q1		
Limp	*Lexr*	*Lppi*
-1	0.72 (0.03)	1.29 (0.16)
Panel A(ii): Restriction based on the likelihood ratio test		
Restriction: $\alpha_1 = \alpha_2$	Test statistic $\chi^2(1) = 3.85$**	
Panel B: Tests for cointegration between *Limp*, *Lexr* and *Lppi*: 1987q1-1997q1		
H_0	λ max eigenvalue	λ trace
r = 0	21.37**	32.77**
r ≤ 1	11.27	11.39
r ≤ 2	0.11	0.11
Panel B(i): Long-run elasticities over the period 1987q1-1997q1		
Limp	*Lexr*	*Lppi*
-1	0.72 (0.09)	1.18 (0.34)
Panel B(ii): Restrictions based on the likelihood ratio test		
Restriction: $\alpha_1 = \alpha_2$ Restriction: $\alpha_1 = \alpha_2 = 1$	Test statistic: $\chi^2(1) = 1.09$ Test statistic: $\chi^2(2) = 11.64$***	
Panel B(iii): Long-run elasticities with restriction $\alpha_1 = \alpha_2$ imposed		
Limp	*Lexr*	*Lppi*
-1	0.82 (0.01)	0.82 (0.01)

Notes:

1. *** denotes significance at the 1% level and ** at the 5% level.
2. The figures in parentheses in panel A(i), B(i) and B(iii) are asymptotic standard errors.
3. The order of the VAR model is six ($k = 6$).
4. The Akaike Information and Schwartz Bayesian selection criteria were used to determine the order of the VAR. In cases where the two selection criteria contradicted each other, a likelihood ratio test was performed to eliminate lags from a general to a more specific model.
5. The critical values computed by Osterwald-Lenum (1992) were used to determine the deterministic components in the underlying VAR model. In each case the constant was restricted to lie outside the cointegration space without a trend.

Table IV

Long-run determinants of price inflation

Variables	1973q1-1983q4	1987q1-1998q4
$\dot{e}D_t$	0.68	–
$\dot{q}_t$	–	-0.88
$i\dot{m}p_t$	0.10	0.83