

A macro-economic examination of the price-formation process in the South African economy

by C.J. Pretorius and M.M. Smal

1. Introduction

South Africa has been troubled by relatively high inflation since the beginning of the 1970s. Over this period inflation expectations became firmly entrenched and until fairly recently people have generally assumed that inflation will continue at a rate in the region of 15 per cent per year.

In 1989 the Reserve Bank announced its intention to deal effectively with the problem of inflation. The Bank then adopted as its mission the protection of the internal and external value of the rand. The Bank proclaimed in no uncertain terms that its future actions would concentrate on the need to obtain financial stability in order to reduce the rate of inflation.

For a while it appeared as if the Bank's efforts met with little success. Inflation remained high and at times moved even higher under the impact of some price-raising exogenous shocks. Only after a protracted period of persistently restrictive monetary policy did price increases begin to subside.

In some circles the long delay in the response of prices to the tightening of policies was interpreted as an indication of the impotence of monetary policy. However, such a delay is perfectly reconcilable with a theoretical model of the price-formation process that was developed by the Economics Department of the Reserve Bank during the first half of the 1980s.

The purpose of this paper is to describe the price-determination process as contained in the econometric model of the Bank. The development of this theoretical model is depicted in Section 2 of the paper. The most important variables of the model, which is based predominantly on the expectations-augmented version of the Phillips curve, are then discussed briefly in Section 3. The quantification of the price-forming process is portrayed by means of economic equations in Section 4 and the price-determination process is summarised in a flow chart in Section 5. Some pertinent remarks with regard to the curbing of inflation, as they are suggested by the study, are made in Section 6.

2. A theoretical model of price-determination

The point of departure for the description of the price-formation process is that output prices are essentially determined as a fixed mark-up over costs. When output prices are defined as value-added deflators and output itself is defined as the value-added concept of the national income and product accounts, labour

costs become the most important single cost element. In accordance with this simplification, output prices are derived as a fixed mark-up over labour costs.

Labour's share in the aggregate value of output has traditionally been expressed in mathematical terms as:

$$\alpha = \frac{WN}{Py} \quad (1)$$

where W = nominal labour costs (wage) per unit of labour input,

N = number of units of labour input,

P = final product price per unit of output, and

y = the physical volume of output.

By rearranging Equation (1), output prices can be expressed as the product of a constant mark-up factor and the costs of labour per unit of output:

$$P = \frac{1}{\alpha} \times \frac{WN}{y} = \mu \times \text{ULC} \quad (2)$$

where $\mu = \frac{1}{\alpha}$ = mark-up factor, and

$$\text{ULC} = \frac{WN}{y} = \text{the cost of labour per unit of output.}$$

A simple algebraic manipulation of the expression for unit labour costs reveals that unit labour costs can be written as the quotient of the nominal wage and the average productivity of labour¹:

$$\begin{aligned} \text{ULC} &= \frac{W}{y/N} \\ &= \frac{W}{A} \end{aligned} \quad (3)$$

where $A = y/N$ = average output per unit of labour input, i.e. average labour productivity.

Incorporating Equation (3) into Equation (2) and

¹ From this formulation follows that the ratio which is usually labelled as "real unit labour costs" ($\frac{W}{y/N}$) is equal to labour's share in the aggregate nominal value of output ($\frac{WN}{y}$).

rewriting the resultant expression in terms of percentage changes gives the following expression for output price changes:

$$\dot{P} = \dot{W} - \dot{A} \quad (4)$$

where a dot over a variable indicates percentage change.

Equation (4) indicates that changes in final output prices are the net result of changes in wage rates less changes in the average productivity of labour. If nominal wage growth exceeds productivity growth, output prices rise. Conversely, if nominal wage growth falls short of productivity growth, output prices will fall according to Equation (4). Only when wage growth matches productivity growth will price stability prevail.

It can reasonably be assumed that price-setters respond to changes in nominal wage rates in a manner that differs from their response to changes in average labour productivity. In the short term, movements in prices are more likely to be dominated by changes in wage rates rather than by changes in productivity levels.

Although measured labour productivity may exhibit fairly dramatic changes in the short term, such changes are usually short-lived and are soon reversed. In contrast, fundamental changes in labour productivity are likely to occur gradually as the existing labour force acquires new skills, production techniques become more advanced and skilful management succeeds in improving the cost-efficiency of the production process.

Nominal wage increases (just as productivity changes) are highly volatile over the course of the business cycle, but rising wages (unlike short term productivity increases) are rarely reversed by later declines in nominal wages. Wage increases in the short term therefore tend to swamp the impact of productivity improvements on prices. Thus, attempts to explain short term price-setting behaviour have to focus much more closely on wage changes than on productivity changes.

A popular approach for explaining changes in nominal wages finds its origin in Phillips' statistical analysis of the relationship between wage rate changes and unemployment rates in the United Kingdom.² Phillips' statistical analysis pointed to a direct negative relationship between the rate of increase of nominal wages and the unemployment rate. This relationship can be formulated as follows:

$$\dot{W} = f(u), f' < 0 \quad (5)$$

where u indicates the unemployment rate and f' the first derivative of the functional relationship.

The original relationship between nominal wage changes and the unemployment rate, or the so-called Phillips curve, was widely interpreted as offering a menu of policies which allowed policy-makers to choose between various combinations of rates of wage increases and unemployment rates. Less unemployment was attainable according to the Phillips curve, but at the cost of faster wage inflation. Economies with a preference for lower inflation could, on the other hand, indulge this preference, but would then have to accept a higher unemployment rate.

The possibility of obtaining a stable trade-off between wage rises and unemployment was not confirmed by developments in many industrialised countries during the 1970s. Most of these countries experienced a more or less unchanged unemployment situation coupled with a variable inflation rate. This contradicted the original view of the Phillips relationship that nominal wage growth and unemployment were uniquely related.

The developments of the 1970s called for a revision of the Phillips relationship between wages and unemployment. To allow the same unemployment rate to co-exist with multiple inflation rates, it was suggested that inflation expectations should be added as an explanatory variable in the wage-determination model.³ This expectations-augmented version of the model postulates that a nominal wage increase, which may be acceptable to workers for a given unemployment rate and inflation rate, is unlikely to be acceptable when unemployment remains unchanged, but inflation is expected to be much higher than before.

A further theoretical insight which was added to the wage-determination model in order to eliminate some of its perceived deficiencies, is that so-called "full employment" of labour is consistent with some unutilised labour resources. Such unemployment is fully compatible with equilibrium in the goods and labour markets and results from unavoidable frictions in the functioning of these markets. Expressed as a percentage of the total labour force, such unemployment is referred to as "natural" and its accompanying unemployment rate as the "natural rate of unemployment". It differs from country to country and is mainly determined by factors such as the degree of unionisation of labour supply, labour mobility, cost of information and search confronting job seekers, the availability of unemployment benefits and other factors that may inhibit the productive utilisation of all labour resources. The natural rate is not affected by short-term stabilisation policies, but it can be influenced by government policies regarding the structure and functioning of the labour market, such as education programmes, minimum-wage

² Phillips, A.W.: "The relationship between unemployment and the rate of change in money wage rates in the U.K., 1861-1957", *Economica*, November 1958, pp. 283-299.

³ See Friedman, M.: "The role of monetary policy", *American Economic Review*, March 1968, pp. 1-17.

legislation, unemployment compensation, social security programmes, re-training of unemployed workers and the availability of labour-market information. Sustained inflation, through its debilitating effect on the efficient functioning of a market economy, is also likely to raise the natural rate of unemployment to a higher level.

A wage-determination model based on the view that workers are remunerated according to productivity improvements and incorporating the original ideas of Phillips, inflation expectations and the natural rate hypothesis, can be presented algebraically as follows:

$$\dot{W} = a_1(u - u^*) + a_2\dot{A} + a_3\dot{p}^e, \quad a_1 < 0; \quad a_2, a_3 > 0 \quad (6)$$

where u^* = natural rate of unemployment, and
 \dot{p}^e = expected future inflation rate.

All the other symbols have the same meaning as before.

Equation (6) states that wage changes are inversely related to the unemployment rate (u). For low levels of unemployment, or when the actual unemployment rate is below the natural rate ($u - u^* < 0$), nominal wage increases will be higher. When unemployment increases during times of economic slack to levels exceeding the natural rate ($u - u^* > 0$), downward pressure is likely to be exerted on changes in nominal wages. Equilibrium in the labour market will be attained when the actual unemployment rate matches the natural rate. In such an event, wage rises may still occur because of increases in labour productivity and the persistence of inflation expectations.

Equation (6) served as the basis for the estimation of an empirical function explaining nominal wage change in South Africa. The inadequacy of information on unemployment, however, necessitated a slight modification of the unemployment variable. Following Okun⁴ it is assumed that a direct relationship exists between the unemployment rate and the difference or gap between potential aggregate production and actual aggregate production. This implies the existence of a certain output level where the gap between potential production and actual production is consistent with equilibrium in the labour and goods markets – a so-called "natural output gap". The output gap and the natural output gap were consequently substituted for the unemployment rate and the natural unemployment rate in Equation (6).

Some interesting conclusions can be made from this wage-determination model. If it is assumed that labour is fully rewarded for productivity improvements

and fully compensated for expected inflation, both a_2 and a_3 in Equation (6) equal unity. By incorporating Equation (6) (with $a_2 = a_3 = 1$) into Equation (4), the following relationship is obtained:

$$\dot{p} = a_1(G - G^*) + \dot{p}^e, \quad a_1 < 0, \quad (7)$$

where G and G^* indicate the actual and the "natural" output gaps, respectively. Equation (7) can be adjusted slightly as follows:

$$\dot{p} - \dot{p}^e = a_1(G - G^*), \quad a_1 < 0. \quad (8)$$

From Equation (8) it can be deduced that attempts to permanently reduce the actual output gap below its natural level⁵ requires actual inflation to be consistently higher than expected inflation. If it is assumed that inflation expectations will eventually adjust to actual inflation, a continuously accelerating inflation rate is necessary to ensure that the actual output gap is permanently lower than its natural level. Thus, according to the postulated wage-determination model it is possible to encourage higher output and employment levels by allowing inflation to accelerate. However, if the expectations-formation process is such that inflation expectations ultimately adjust to actual inflation, the output gap will widen once again and return to its natural level, leaving the economy with a higher rate of inflation and without any durable improvement in the level of output and income.

3. The variables of the model

The variables of the specified model are described briefly in this section. A distinction is drawn between endogenous variables (whose values are determined within the framework of the model) and exogenous variables (whose values are not determined within the model, but which play a prominent role in the determination of the values of the endogenous variables).

Endogenous variables

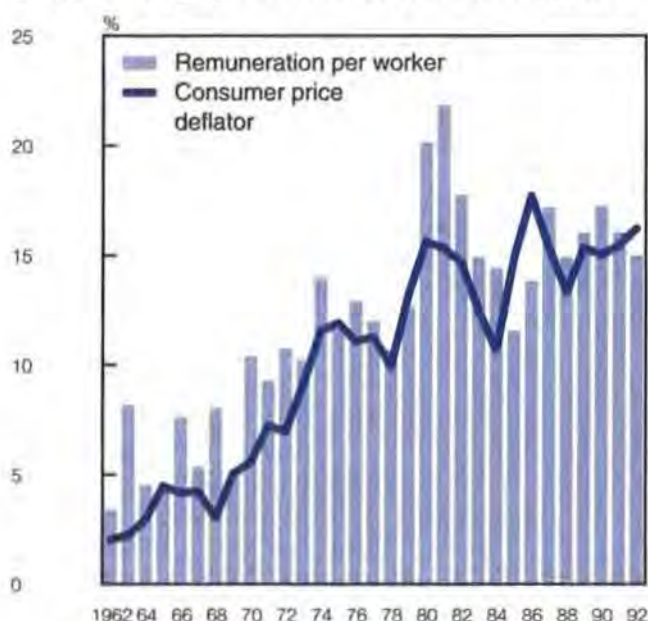
Wage per worker

The dependent variable in the wage equation is calculated as the percentage change over four quarters in the average remuneration per worker in the non-agricultural sectors, excluding the gold-mining sector and the general government. Aggregate labour

⁴ Okun, A.: *Potential GNP: Its measurement and significance*, Proceedings of the Business and Economic Statistics Section of the American Statistical Association, 1962.

⁵ This is equivalent to reducing the unemployment rate below its natural level or raising actual output beyond the level consistent with the full employment of labour resources.

Graph 1: Wage per worker and the inflation rate



Graph 2: Output prices and the wage per worker



remuneration was obtained from national accounts statistics, whereas employment data were compiled from information released by the Central Statistical Service. The average wage per worker was derived by dividing aggregate labour remuneration by the estimated number of employees.

Changes during calendar years in nominal labour remuneration per worker and consumer price inflation are indicated in Graph 1. Of great significance is that the increase in the average remuneration per worker in the private sector exceeded inflation in almost every year since the early sixties.

Output prices

The deflator for the gross value added in the non-agricultural sectors, excluding the general government and the gold-mining sector, is used as a best approximation for output prices. Estimates of the value-added deflator were derived from the national accounts statistics as the ratio of value added at current factor cost to value added at 1985 factor cost.

As indicated earlier, output prices in the model are determined as a mark-up over cost. For purposes of the wage-price model it was assumed that labour costs dominate the overall cost-structure of South Africa's productive business sector. This assumption is confirmed by Graph 2 which indicates a relatively close relationship between changes in unit labour costs and output prices.

Consumer prices

The derived deflator for private consumption expenditure is an alternative indicator for the general level of consumer prices. The derived deflator differs from the consumer price index in that it covers the entire economy and not just the urban areas, and that it is a current-weighted index with weights continuously adjusting to changes in spending patterns, instead of the fixed-weight structure of the consumer price index. Changes in this derived deflator over four quarters are equated with inflation. The deflator was obtained by dividing private consumption expenditure as estimated in the national accounts at current prices by private consumption expenditure valued at 1985 prices.

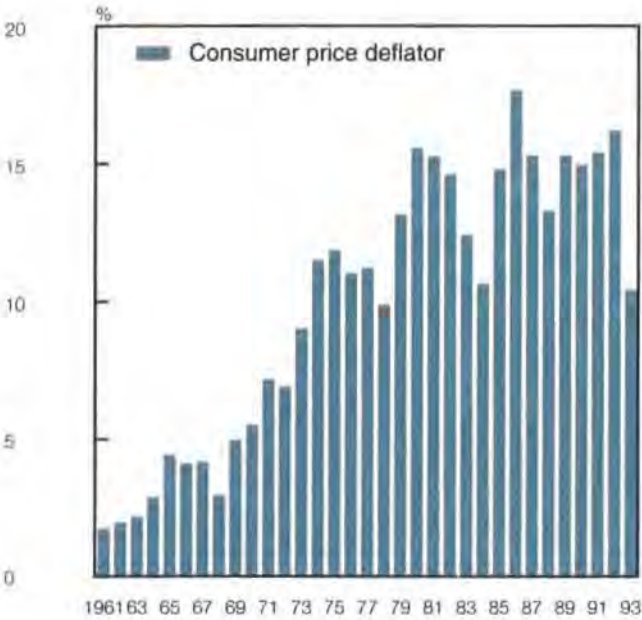
As indicated in Graph 3, the South African economy experienced a comparatively high degree of price stability in the 1960s with single-digit inflation prevailing until 1973. Inflation reached double-digit proportions in 1974 and has remained at a comparatively high level since then.

Exogenous variables

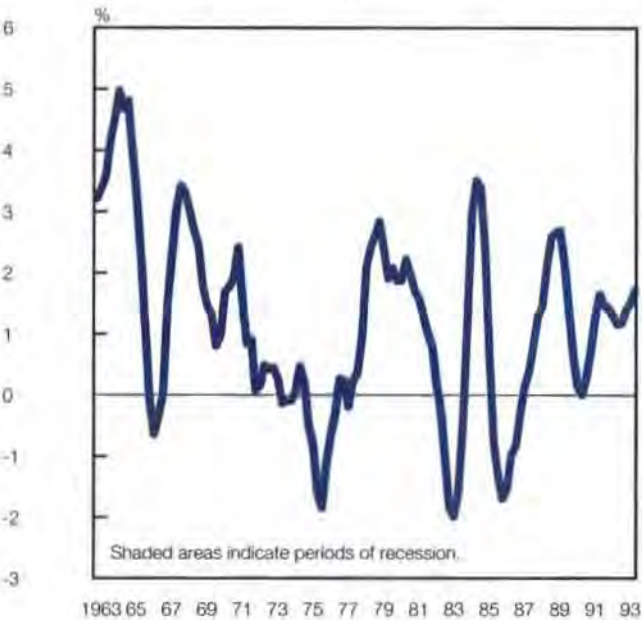
Labour productivity

The percentage change over four quarters in the output per worker in the non-agricultural sectors, excluding the general government and the gold-mining sector, is used as an indicator for labour productivity growth. The real gross domestic product at factor cost is used as an indicator for output, whereas the

Graph 3: The inflation rate



Graph 4: Change in labour productivity



employment data in the non-agricultural sectors have been compiled from information published by the Central Statistical Service.

The average productivity of labour, i.e. the level of output per unit of labour, varies procyclically. Graph 4 indicates that the output per worker tends to fall at least during the early stages of a period of economic contraction and increases in the advanced stages of prolonged contractions and once the recovery gets under way. This could be attributed to the fact that firms are reluctant to lay off workers when output declines, as such declines in output may well be only temporary. This was particularly the case when rigidities in the labour market severely curbed the mobility of labour in the country.

Economic theory postulates a large degree of interdependence between wages and productivity. Wage growth reflects productivity growth, whilst productivity itself can also be influenced by the wage level. The law of diminishing marginal productivity whereby successive units of labour hired yield successively diminishing returns, serves as a guideline to employers who want to maximise their profits. At a given level of wages, additional labour will be hired until the marginal productivity of the last unit employed equals the wage paid.

Output gap

The gap between the potential gross domestic product and the actual gross domestic product⁶ is used as an indicator of the under-utilisation of productive

resources. The average output gap over the sample period provides an indication of the natural unemployment rate. The difference between the actual output gap and its natural level is used as an explanatory variable in the wage equation.

When the output gap falls below its natural level, it indicates that upward pressure is being exerted on wages, whereas an output gap above the natural level indicates the existence of excess capacity and the absence of upward pressure on wages.

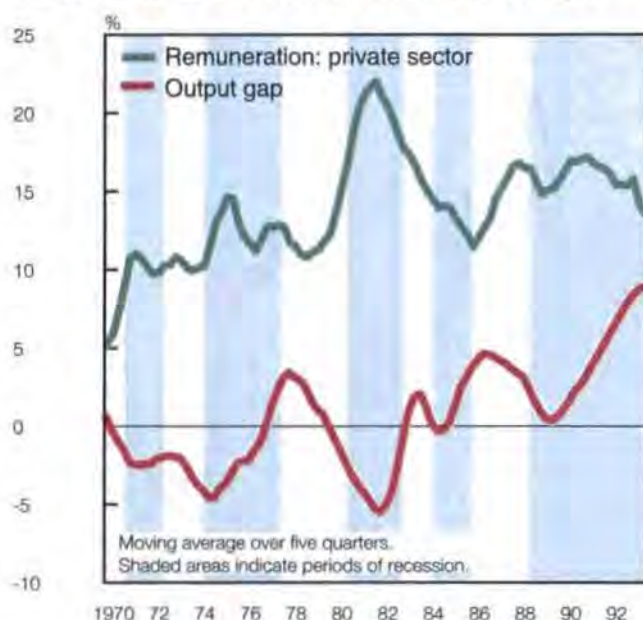
The inverse relationship between the wage per worker in the private sector and the difference between the output gap and its natural level is illustrated in Graph 5. Accelerating wage growth broadly corresponds with higher capacity utilisation, and slower wage growth with rising under-utilisation of production potential.

Inflation expectations

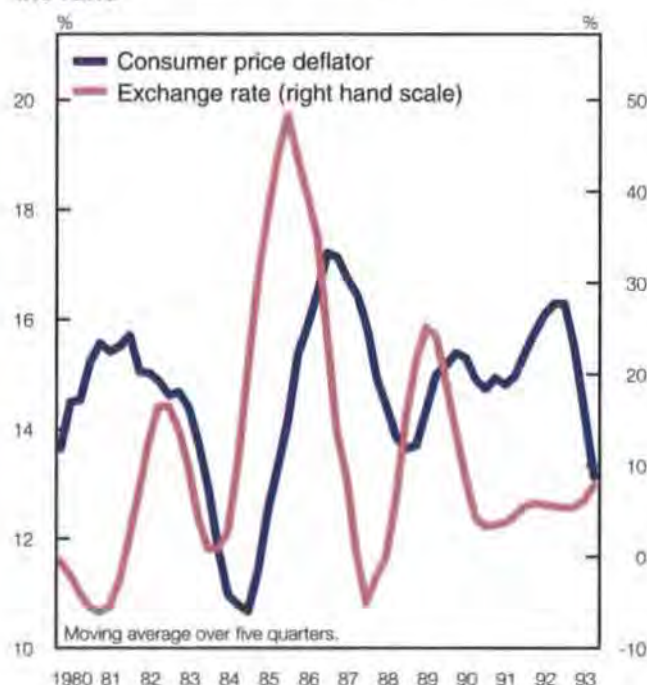
Inflation expectations in any particular period can be estimated in many ways. One method is to use actual inflation of the past as an indication of the future inflation rate. Alternatively, a weighted average of actual inflation rates in a number of periods can be regarded as an approximation of what future inflation

⁶ For a description of the calculation of the potential gross domestic product see De Jager, B.L. and Smal, M.M.: "The potential gross domestic product of South Africa.", *Quarterly Bulletin* of the South African Reserve Bank, December 1984.

Graph 5: Wage per worker and the output gap



Graph 6: The inflation rate and changes in the nominal effective exchange rate of the rand



can reasonably expected to be. The rational-expectations model suggests that the expected inflation rate in any period is based on all information available to decision-makers at that moment. This information may include the past performance of the economy and expectations of future policies likely to be implemented by the authorities. This approach assumes that policy-makers act according to clearly defined policy rules which are fully understood by decision-makers in the private sector. Changes in selected key variables, such as the money supply, interest rates, the exchange rate and the budget deficit, may thus be regarded as indicators of policies which influence inflation expectations. In this analysis a quantity theory approach is adopted and inflation expectations are explained by the growth in M3 money supply and changes in output volumes. Allowance is also made for the effect that changes in import prices are likely to have on future inflation and the carry-over effect of historical inflation to expected inflation.

Import prices

The deflator for imports of goods and non-factor services is used as an indicator of import prices. Changes in the exchange rate of the rand against other currencies play a prominent role in the explanation of domestic price changes, primarily through the influence on the prices of imported goods.

Graph 6 shows the relationship between the consumer price inflation rate and the changes in the

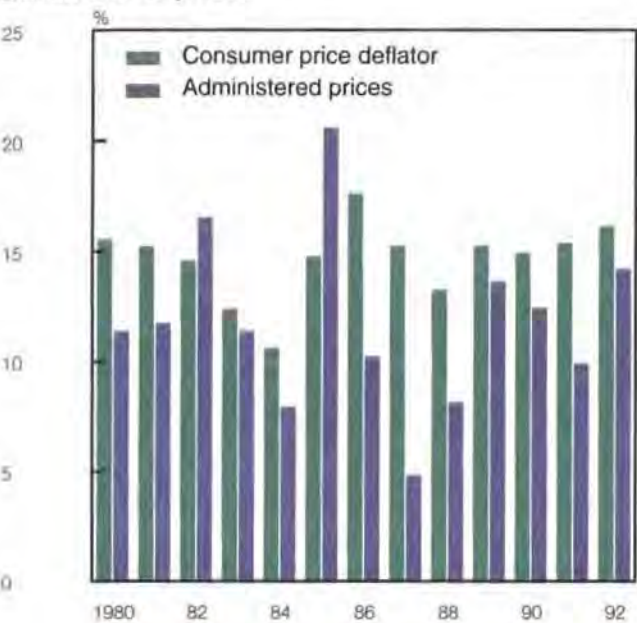
nominal effective exchange rate of the rand. Cross-correlation tests indicate that domestic price changes follow changes in the exchange rate by 3 to 4 months. For most of the 1980s the delayed response of consumer price inflation to exchange rate changes is clearly reflected in this graph. This relationship became blurred from about 1989 when the exchange rate movements began to exhibit considerably less volatility and domestic prices were affected particularly by other factors.

Administered prices

Graph 7 compares increases in administered prices with general consumer-price inflation. On average, administered prices tended to rise somewhat more slowly than the prices of all consumer goods and services.

The move during the 1980s towards an increased reliance on market forces in official economic decision-making saw the importance of administered prices in the overall consumer price index declining from 24,6 per cent in 1981 to 10,8 per cent in 1992. Over time the significance of officially determined price changes has thus been reduced. Accordingly price changes are being influenced much more strongly than before by market forces and it seems reasonable to expect that prices are likely to show an increased responsiveness to policy measures aimed at restoring financial stability.

Graph 7: The inflation rate and changes in administered prices



Remuneration of government employees

The wage-determination process is influenced by the formal and informal comparison by workers of their own wages and the wages of workers in other sectors of the economy. The salary increases of civil servants are often used as a formal guideline for determining salary increases of individuals in the private sector performing similar duties. The remuneration of employees in the private sector is, on the other hand, often used to determine wages and salaries in the government sector. Comparisons are also made on an informal basis by both employers and employees to establish a suitable frame of reference for deciding wage levels.

National accounts statistics served as a basis for the calculation of the average remuneration of employees of the government and the private sector. The average increase in the remuneration of employees in the general-government sector and the private

Table 1
Remuneration of employees and the inflation rate

	70-90 %	80-90 %	85-92 %
Increase in remuneration of employees:			
General government	14,3	17,4	16,9
Private sector.....	14,1	16,2	15,2
Inflation rate	12,4	14,6	15,3

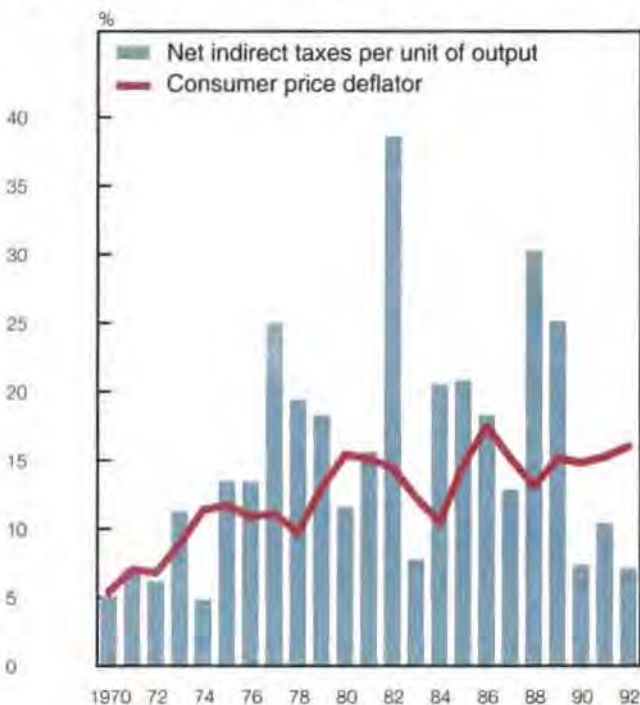
sector is compared with the inflation rate for three sub-periods in Table 1. The data reveal that since 1970 the increase in the remuneration of employees in the government sector has on average been higher than both the inflation rate and the increase in the average salaries and wages of employees in the private sector. Yearly changes in the remuneration of employees in the government sector show larger fluctuations than changes in the remuneration of the private sector. Salary adjustments in the government sector are below inflation in some years, but are often followed in ensuing years by adjustments well in excess of the inflation rate.

Net indirect taxes

Net indirect taxes are introduced into the model for technical reasons. Final output prices in the model are derived from national accounts aggregates valued at factor costs, i.e. excluding net indirect taxes. Consumer prices, in contrast, are end-user prices and therefore incorporate all indirect taxes added to production costs. When end-user prices are assumed to be determined by production costs, the impact of net indirect taxes on consumer prices has to be explicitly allowed for in the price formula.

Graph 8 suggests that net indirect taxes, i.e. indirect taxes less subsidies per unit of physical output, increased at a much faster rate than inflation during the period from 1970 to 1989. Since 1990 this tendency has been reversed and increases in net indirect taxes

Graph 8: Net indirect taxes and the inflation rate



were well below the inflation rate. The relatively large increases that occurred during 1982, 1984 and 1989 can be partly attributed to increases in the general sales tax rate during those years, whilst the increase in 1988 can be ascribed to the introduction of the fuel levy.

4. Statistical estimation of wage and price equations

In this section the results of the statistical estimation of the theoretical model are discussed. Ordinary least squares estimation techniques were applied and the t-values of the estimated coefficients and the following summary statistics are tabulated:

\bar{R}^2 = Adjusted coefficient of determination;

D-W = Durbin-Watson d-statistic;

RHO = Autocorrelation coefficient.

Quarterly data were used and the period of estimation is also indicated.

Wages in the private sector

The dependent variable in the wage equation is the percentage change over four quarters in the average nominal remuneration per worker in the non-agricultural sectors, excluding the gold-mining sector and the general government, and is denoted by \dot{W}_p . The following explanatory variables are included in the equation:

- the difference between the output gap, expressed as a percentage of potential output, and the average percentage output gap over the sample period ($u=G-G^*$);
- the percentage change over four quarters in the real output per worker in the non-agricultural sector, excluding the general government and the gold-mining sector (A);
- inflation expectations, based on changes in the derived deflator for private consumption expenditure (\dot{p}^e); and
- a dummy variable (\dot{v}), used to indicate the entry to and presence of labour unions in the labour market since 1980, with 1980.I to 1992.IV = 1.0, and 0 otherwise⁷.

The estimated wage equation is as follows:

$$\dot{W}_p = 0,89 \cdot \dot{p}^e - 0,55 \cdot (0,25 \sum_{i=0}^3 u_{t-i} - 9,3) + 0,60 \cdot \dot{A} + 2,87 \cdot \dot{v}$$

(17,43) (5,26) (6,06) (3,22)

$\bar{R}^2 = 0,45$

D-W = 1,70

RHO = 0,48

Estimation period: 1970.I to 1992.IV

The relatively low \bar{R}^2 -value can be attributed to the fact that the dependent variable is the percentage change in wages over four quarters, which is subject to large fluctuations.

Because all the variables, apart from the dummy variable, are expressed as percentage changes, the estimated coefficients can be interpreted as elasticities. The coefficients accordingly indicate the percentage change in the nominal wage that can be expected from a change of one per cent in the relevant explanatory variable. The size of the coefficient of the dummy variable indicates that labour unions were very successful in accelerating the rate of wage increases. On average, the rate of nominal wage increase rose by about 2% percentage points per year when labour unions for black workers were legalised at the beginning of the 1980s.

Productivity growth has been properly accounted for in nominal wage growth during the estimation period. Over the period since 1970 labour has been rewarded for productivity increases broadly in proportion to its share of the value of output – about 60 per cent of the rise in productivity was allocated to nominal wage growth. This implies constancy of the distribution of income between labour and capital in the long run.

According to the estimated equation, upward wage pressure is likely to arise when idle productive capacity is reduced to a level below 9,3 per cent of total productive capacity. When unutilised productive capacity equals 9,3 per cent of potential output, wage changes will no longer be influenced by excess demand pressures. Under such circumstances nominal wage growth will be determined by other forces, such as inflation expectations, productivity growth and the bargaining power of trade unions. At this rate of idle capacity, wage inflation will not be accelerating nor decelerating because of excess or insufficient demand. The estimated equation therefore agrees with the theory of a non-accelerating inflation rate of unemployment (NAIRU), with the implication that there is a trade-off between higher wage inflation and lower unutilised capacity in the short term, but that inflation will be the only lasting outcome of such a demand-management policy in the long run.

The estimated wage equation also resembles a very flat trade-off between idle productive capacity and wage

⁷ The stability of the estimated equation over the entire period was the prime consideration for the inclusion of the dummy variable. See the section under the heading "Tests for structural change" below.

inflation in the short term. According to these results unutilised productive capacity will have to rise to about 18,4 per cent of potential capacity in order to reduce nominal wage growth by 5 percentage points. This means that in the absence of other forces favouring lower wage growth, a very deep recession is required to slow the rate of increase in nominal wages significantly.

The estimated equation also confirms that inflation expectations play an important role in the wage formation process. All other things equal, expected inflation of 10 per cent per year is likely to increase nominal wages by almost 9 per cent per year. This high sensitivity of changes in nominal wages to inflation expectations, combined with the relative inflexibility of wages to respond to slack demand and a rising output gap, indicates that attempts to curb inflation by means of orthodox demand-restraining policies could turn out to be costly in terms of output and employment losses, especially if not applied consistently. If policy measures are not perceived to be credible, inflation expectations are unlikely to adjust to the desired degree and economic activity will have to decline substantially to bring about the desired results. A consistent conservative monetary policy is therefore required to restore policy credibility and price stability at the lowest cost to the country in terms of lost employment opportunities and lower production.

The price functions

The model distinguishes between a production price function and a consumer price function.

The production price function

The equation for production prices is a linear approximation of the mark-up relationship between production costs and output prices. Labour costs and the costs of imported goods are singled out as the most important cost elements influencing output prices. Net indirect tax payments by producers are, however, not taken into consideration at this level of the price-formation process because the value-added deflators are derived from national-accounts aggregates at factor costs. The costs of goods and services rendered by public-sector bodies and parastatal corporations are captured by the inclusion of the average wage costs of workers in the general government sector.

The deflator for the gross value added in the non-agricultural sectors, excluding the general government and the gold-mining sector, is used as the dependent variable and as proxy for output prices (p_p). The explanatory variables are:

- the deflator for consumption expenditure by the general government (remuneration of employees), used as a proxy for the cost of general government services (w_g);

- the average wage per worker in the non-agricultural sector, excluding the general government and gold-mining sector, used as a proxy for unit labour costs in the private sector (w_p); and

- the prices of imported goods and services (p_i).

The estimated function is as follows:

$$p_p = 0,05 + 0,84 \cdot (0,8 \cdot w_p + 0,2 \cdot w_g) + 0,14 \cdot p_i$$

(7,95) (44,53) (5,23)

$$\bar{R}^2 = 0,99$$

$$D-W = 1,94$$

$$RHO = 0,65$$

Estimation period: 1970.I to 1992.IV

The consumer price function

The equation describing the relationship between consumer prices and production prices allows explicitly for the direct effects of the prices of imported goods and administered prices on end-user prices. The dependent variable in the consumer price function is the derived deflator for private consumption expenditure (p_v). The variables used to explain consumer prices are:

- administered prices (p_a), weighted with the share of administered prices in the consumer price index (w_{p_a});

- production prices (p_p); and

- the prices of imported goods and services (p_i), weighted with the share of imported prices in the consumer price index (w_{p_i}).

The estimated function is as follows:

$$p_v = w_{p_a} \cdot p_a + w_{p_i} \cdot p_i - 0,08 + 0,83 \cdot p_p$$

(3,08) (51,96)

$$\bar{R}^2 = 0,97$$

$$D-W = 1,78$$

$$RHO = 0,90$$

Estimation period: 1975.I to 1992.IV

Equation for inflation expectations

The inflation expectations variable is based on the percentage change over four quarters in the derived deflator for private consumption expenditure (\dot{p}^e). The explanatory variables which play a role are:

- the growth rate over four quarters in the M3 money supply per unit of production (\dot{M}_y);

- the percentage change over four quarters in the price of imported goods (\dot{p}_i); and
- the inflation rate in the preceding period (\dot{p}).

The estimated function is as follows:

$$\dot{p}^e = 0,04 \cdot \dot{M}y_{-2} + 0,04 \cdot \dot{p}_i + 0,93 \cdot \dot{p}_{-1}$$

(1,86) (3,01) (39,60)

$$\bar{R}^2 = 0,95$$

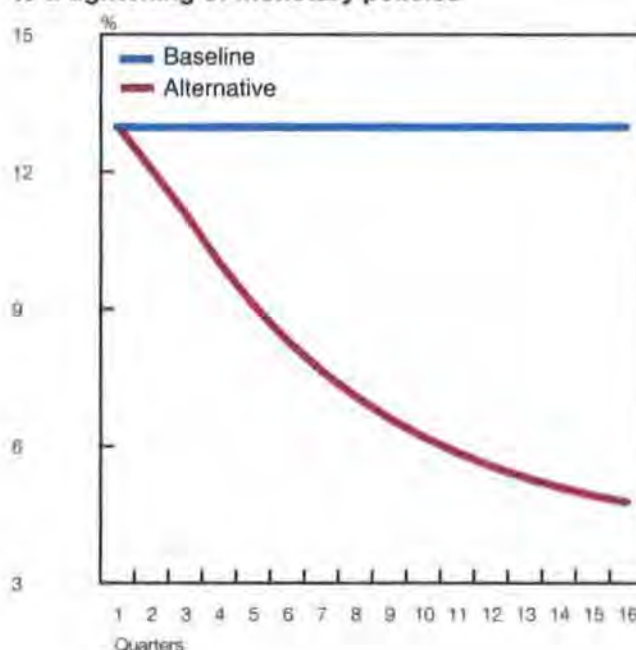
$$D-W = 2,38$$

Estimation period: 1961.IV to 1992.IV

According to this hypothesis the expectations-formation process is dominated by past inflation. The estimated equation states that expectations are unlikely to adjust speedily to a reduction in monetary growth. By slowing monetary growth from 15 per cent per year to 5 per cent per year, the expected inflation rate will probably be reduced in the short term by only 0,4 percentage points. The further lowering of expectations will take place gradually and the feed-through effect to lower nominal wage settlements is similarly likely to be a drawn-out process. However, once a credible policy has been established and evidence of a significant lowering of inflation becomes visible, inflation expectations may subside considerably faster. In order to have a lasting effect on firmly entrenched inflation expectations, tight monetary policies will have to be pursued for a rather prolonged period of time. A quick response of inflation expectations to a tightening of monetary policies will probably require some unorthodox measures to encourage decision-makers in the private sector, particularly those in the labour market, to change the way in which they formulate expectations of future price increases.

Graph 9 presents a single-equation simulation of the response of inflation expectations to a tightening of monetary policies. In the baseline simulation, monetary

Graph 9: Response of inflation expectations to a tightening of monetary policies



growth was assumed to persist at 15 per cent per year, ensuring that inflation can be expected to be sustained at about 13 per cent per year. In the alternative simulation it was assumed that money growth is reduced permanently to 5 per cent, implying a long-run inflation rate of about 3 per cent. The alternative simulation indicates that only after the elapse of four years (sixteen quarters) did inflation expectations subside from 13 per cent to about 5 per cent.

Tests for structural changes

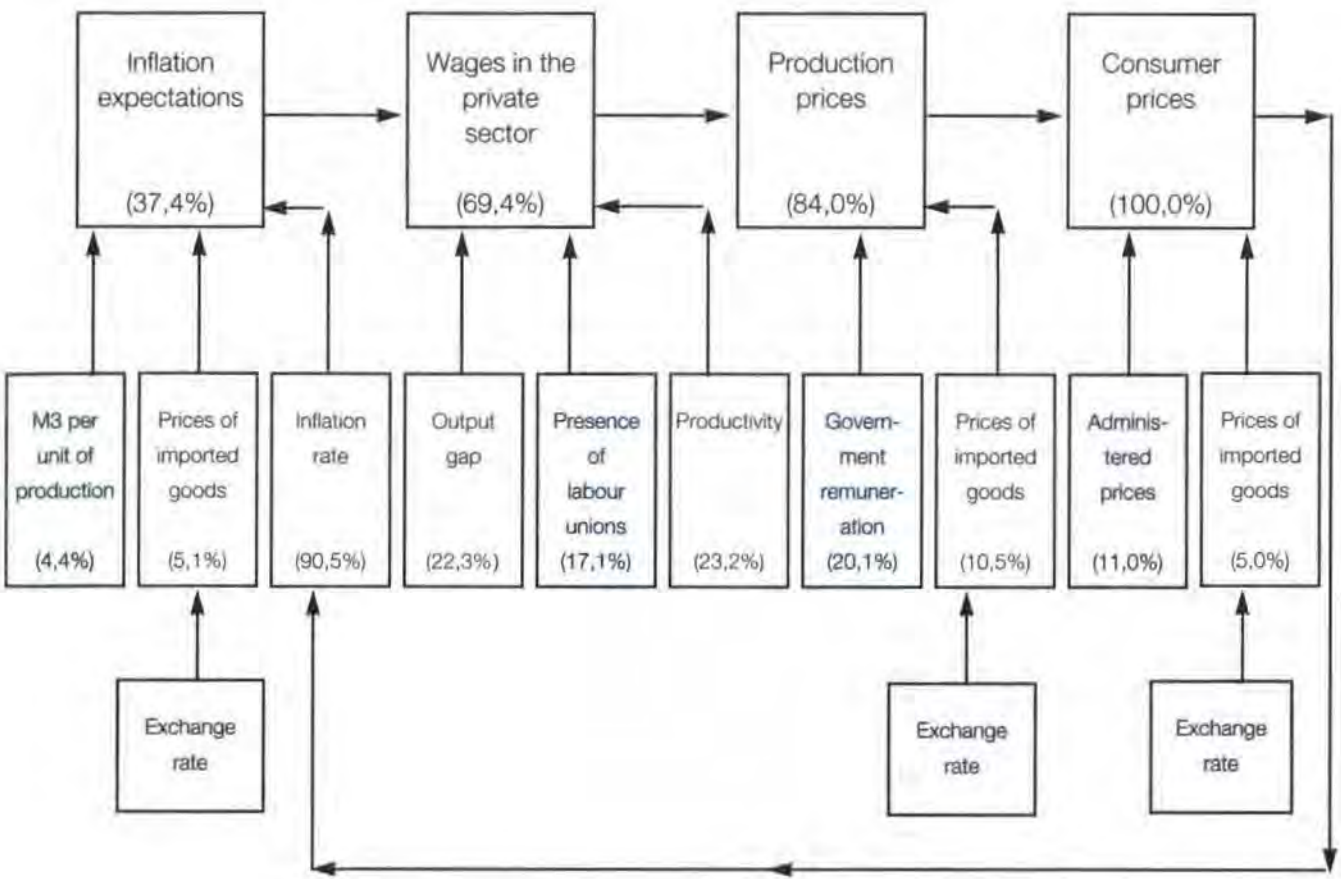
In order to test the stability of the estimated equations, regressions were performed over different estimation

Table 2
Goodness of fit (determination coefficients) of the functions

Function	Estimation period						
	1970 - 1980	1970 - 1982	1970 - 1984	1970 - 1986	1970 - 1988	1970 - 1990	1970 - 1992
Remuneration in the private sector .	0,454	0,577	0,520	0,413	0,387	0,361	0,357
Production prices	0,993	0,991	0,987	0,992	0,995	0,997	0,997
Consumer prices*	0,983	0,991	0,979	0,986	0,984	0,989	0,986
Inflation expectations.....	0,779	0,828	0,818	0,844	0,846	0,847	0,857

* The estimation period starts from 1975.

Diagram
Flow chart of the price-formation process



The percentage change in brackets is the beta-coefficient and indicates the change in the dependent variable for a unit change in each explanatory variable.

periods. Only the estimated function for remuneration in the private sector showed a notable weakening in the coefficient of determination (see Table 2)*.

Quandt and Chow tests⁹ were performed on all the functions to test for structural changes. A structural change was detected only in the wage function in 1980. Since 1980 the average rate of wage change was considerably higher than before. A possible reason for this is that labour unions have played a profound role in wage negotiations since that year. The Wiehahn Report¹⁰, which recommended that participation of black unions in the bargaining process be legalised,

was released in 1979 and these recommendations were accepted and implemented by the government in 1980. A dummy variable was therefore introduced in the wage function (as noted above in the description of the wage equation) and the function's coefficient of determination improved to 0,45.

5. Flow chart of the price-formation process in the South African Reserve Bank model

A flow chart of the price-formation model is presented in the Diagram. The shaded areas indicate variables which can be influenced significantly by the authorities. The figures in brackets are the beta-coefficients¹¹ obtained from the regression analysis. These coefficients indicate the change in the dependent

* This is the wage equation without the dummy variable to capture the effect of the entry of organised black unions into the labour market.

⁹ Intriligator M.D.: *Econometric Models, Techniques and Applications*, Prentice Hall, 1978.

¹⁰ The Wiehahn Commission: "Report of the Commission of Investigation on Labour Regulation", RP27/1981.

¹¹ Maddala G.S.: *Econometrics*, McGraw-Hill, Inc., 1977.

variable for a unit change in each explanatory variable, keeping other variables unchanged.

The Diagram indicates that inflation expectations are based predominantly on the most recent inflation rate (90,5 per cent of previous inflation feeds through to current expected inflation) and these inflation expectations, in turn, constitute the main explanatory variable in the wage-determination process in the private sector (37,4 per cent of the variation in nominal wages is explained by the price-expectations variable). Wages in the private sector are seen as the most important component (69,4 per cent) in the determination of the production prices. Changes in production prices, in turn, contribute largely to changes in consumer prices (84,0 per cent).

Certain variables in the price-formation process, as described above, can be influenced directly or indirectly by the authorities in order to constrain inflation. The growth in the money supply can be influenced by, among other things, adjustments in the instruments of monetary policy such as the discount rate of the Reserve Bank. A policy-induced depreciation of the rand against a basket of other currencies will lead to an increase in the cost of imported goods and consequently to an increase in the domestic price level. Should the monetary authorities succeed in maintaining a stable exchange rate, the influence of the prices of imported goods on the domestic price level will only be limited to the extent of inflation in South Africa's trading partner countries. The authorities can also attempt to keep increases in administered prices moderate and to restrict increases in the salaries of civil servants below the current inflation rate. Such a policy is not always commendable because it can produce undesired results arising from unintended distortions of relative prices.

The beta-coefficients indicate that inflation expectations and increases in the remuneration of employees are the most important explanatory variables in the price-formation process. According to these coefficients, wage settlements are based largely on inflation expectations and, to a lesser extent, on demand and supply in the labour market. Expected price increases are taken into account during the wage-formation process and inflation is therefore in reality propagated mainly by expectations that it will continue.

6. Constraining inflation

The spiral of inflation expectations and the inflation rate poses a serious problem for policy-makers and also places a responsibility on them to influence the way in which participants in the economic process form these expectations. Policy must be aimed at persuading economic participants to use the *future expected*

inflation rate in the decision-making processes and not the most recent historical inflation rate. This future expected inflation rate ought to be based also on the policy actions pursued by the authorities to influence the inflation rate. If the authorities are able to convince other participants that they are capable of lowering inflation, expectations are likely to be adjusted accordingly. Just as inflation is generated by participants' expectations of price increases, so price stability can be obtained if participants can be let to expect that prices will remain relatively stable in future.

The consistent adherence to a conservative monetary policy and the maintenance of fiscal discipline is the usual way to restore the credibility of the authorities when they embark on an anti-inflation campaign. During such attempts to restore policy credibility, inflation expectations are likely to adjust slowly until the economic participants are convinced that the authorities will persist with their policies. This also explains why real production and job opportunities are affected adversely during the early stages of an active policy programme to reduce inflation from relatively high levels. Once more stable financial conditions have been created, the negative effects of financial discipline will most likely be reduced considerably.

7. Summary

This study has analysed the price-formation process in South Africa by means of a theoretical model. The main conclusions are that changes in labour costs are at the core of the inflation process and that wage-changes are largely driven by inflation expectations. These expectations react slowly to conventional monetary policies directed at reducing the growth in the money supply, until people are convinced that the authorities will persist with a restrictive policy to achieve their stated objectives. In order to influence expectations decisively, a conservative monetary policy will therefore have to be pursued for an extended period. The consistent application of an anti-inflation policy is seen as an absolutely essential part of any programme aimed at stabilising the overall price level at the lowest cost to the country. Attempts to speed up the move towards greater price stability will require unorthodox and perhaps in the end unhealthy methods to reduce inflationary expectations more speedily. Once financial stability has been achieved, the costs of maintaining these conditions will decrease considerably.