The Reserve Bank’s Approach to Inflation Forecasting

In this article Ulf Schoefisch identifies the role of the inflation forecasts within the monetary policy framework and describes the forecasting method underlying the Reserve Bank’s regular updates to the medium-term inflation outlook.

Executive Summary

The Reserve Bank’s approach of targeting inflation directly, rather than using an intermediate target, requires high quality inflation forecasts. A system of econometrically estimated structural price equations constitutes the core forecasting tool. Given that the price equations are not formally linked into a macroeconometric model, assumptions have to be made not only with respect to external price changes which feed into the price equations, but also to capture the influence of domestic real economy developments on the price system. The incorporation of the Reserve Bank’s real economy forecasts into the assumptions on the outlook for unit labour costs and profit margins therefore requires a higher degree of judgemental input than would be the case with a comprehensive model framework.

If justified by the weight of other information, the underlying assumptions and the baseline inflation track generated by the equation system are modified. This is regularly the case with respect to the first two quarters of the forecast period, where specific information exists about changes in the various components of the Consumer Price Index. Furthermore, other forecasting tools, such as leading indicator analysis or vector autoregressive models (VAR models) may suggest changes to the general medium-term trend generated by the equations.

In order to enhance the quality of this forecasting framework, the Bank is currently investigating the possibility of a renewed closer integration of the price equations into a general macroeconomic model to ensure consistency over time between real economy and inflation forecasts.

The Role of the Inflation Forecasts within the Monetary Policy Framework

The Reserve Bank Act determines the maintenance of price stability as the sole objective of monetary policy. Furthermore, the Policy Targets Agreement between the Minister of Finance and the Governor of the Reserve Bank effectively defines price stability as
an annual rate of consumer price inflation of between 0 and 2 percent.\(^1\) Theoretically, there are two alternative options that could provide the effective monetary control mechanism that is required to achieve this target. Firstly, monetary policy could be targeted indirectly at price stability via an intermediate target. An intermediate target variable would not only have to display a close correlation with the rate of inflation, but should also be readily observable and be influenceable by the monetary authority either directly or via other monetary instruments. Over time, the stance of monetary policy would be adjusted in a way that ensured the consistency of the intermediate target variable with the maintenance of price stability. Under the second option, the rate of inflation itself would be the target of monetary policy. Given the lagged effect of monetary policy on inflation, such a regime requires high quality inflation forecasts to enable the appropriate stance of monetary policy to be determined at each point in time.

As discussed in detail in the Bank’s 1993 Post-Election Briefing, none of the potential candidates for an intermediate target variable (monetary aggregates, interest rates, the nominal exchange rate or nominal income) displays a close enough correlation with consumer price inflation in New Zealand. That makes an intermediate target regime unsuitable, particularly in a system with a narrow inflation target range. This has caused the Reserve Bank to adopt the approach of targeting consumer price inflation directly. Changes to the stance of monetary policy thus become a direct function of changes in the inflation forecasts. A superior outcome to that achievable under the intermediate target option relies, firstly, on the quality of the inflation forecasts, and, secondly, on the state of knowledge about the nature of the monetary policy transmission mechanism. The latter refers to the problem of determining an appropriate monetary stance, given a particular set of inflation forecasts.

The Bank produces quarterly medium-term inflation forecasts, which are published in the regular Economic Forecasts and Monetary Policy Statements. The forecasts are generated on the basis of a system of structural econometric equations, which provides a baseline outlook. If the weight of other information justifies it, the baseline outlook, and correspondingly some of the underlying assumptions, are modified. This is regularly the case with respect to the first two quarters of the forecast period, where specific information exists about changes in various components of the Consumer Price Index (CPI). Furthermore, other forecasting tools, such as leading indicator analysis or vector autoregressive models (VAR models) may suggest changes to the general medium-term trend generated by the equations. The forecasting process and the relative weights attached to the forecasting tools are described below.

Core Forecasting Tool: An Econometric Equation System

Theoretical Background and Structure
In general, structural econometric relationships can be used within the inflation forecasting process in the form of either a single CPI equation, a price equation system, or a

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\(^1\) As set out in the Policy Targets Agreement, inflation outside the 0-2 percent range is permitted in a defined set of circumstances. For example, in cases of indirect tax or terms of trade shocks (developments which are beyond the control of monetary policy), the Reserve Bank can invoke caveats which would allow the annual inflation rate to temporarily move outside the 0-2 percent target band.

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comprehensive macroeconometric model that contains a price sector. The first two options require the incorporation of real sector information via exogenous assumptions. The Bank’s Model XII provides a comprehensive macroeconometric framework. However, it has not performed well as a forecasting tool, and the Bank’s approach for some time now has been to use systems of consumer and producer price equations for forecasting purposes. Those equation systems reflect research that shows that producer prices explain a large share of the movement in consumer prices, and that the following core set of variables influences the CPI either directly or indirectly via producer prices: wages, productivity, export and import prices, the nominal exchange rate, and profit margins.

The equations are usually estimated in a way that, firstly, identifies the long-run relationship between the variable being explained (i.e. consumer or producer prices) and the main variables influencing it, and, secondly, specifies the behaviour of the price variables in the short term when deviations from the long-run relationship might occur. The equation specifications imply that the extent and the duration of such deviations are limited. Furthermore, restrictions are usually applied when estimating the long-run relationships. For instance, a theoretically plausible long-run CPI equation would show that a 1 percent increase in all variables that influence the CPI leads to an increase in the CPI by the same factor. Another example is the effect on the CPI of an exchange rate change and an equivalent movement in foreign prices, which should be of the same magnitude in the long run.

The relative weights of the various influences on the CPI vary over time, particularly in periods of structural economic changes. Therefore, the Bank regularly re-estimates its price equations in order to keep up-to-date. Given that the estimation of price equations is a constantly evolving process, no one equation system should be interpreted as being the ‘correct’ one. Instead, the equation system that is being used at a particular point in time represents - in the view of the Reserve Bank - the most suitable system, given the available information at the time. When interpreting the results of a particular set of equations, it needs also to be borne in mind that all equation systems usually have theoretical and econometric deficiencies of some kind.

The table overleaf shows one of the equation systems that has recently been estimated and applied.

Unlike its predecessor, the new equation system has been structured to cover only around 80 percent of the components of the CPI. The 20 percent of the CPI regimen excluded from the CPI definition used in the equation system includes either volatile or non-market driven components. The excluded components have proved difficult to model econometrically and, therefore, are forecast using other methods.

Apart from the different coverage, the previous equation system had a somewhat different structure, with an additional equation for producer output prices providing the link between producer input prices and the CPI. Furthermore, the new equation system

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2 In the context of this article, the term ‘exogenous’ means ‘not generated within a formal quantitative model framework’.
3 House prices and construction costs; mortgage and credit charges; GST; tertiary education fees; hospital and prescription charges; used cars; alcohol and tobacco; fresh fruit and vegetables.
4 Prices of existing dwellings owned by the private sector will not feature in the CPI regimen to be introduced in early 1994.
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<thead>
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<th>Dependent Variable</th>
<th>Explanatory Variables</th>
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<td>Change in Producer Prices (Inputs)</td>
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<td>Change in World Import Prices:</td>
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<td>- Wool (current)</td>
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<td>Consumer Prices (80% of CPI regimen)</td>
<td>Producer Input Prices (current)</td>
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<td>Equation</td>
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<td>- Crude Materials (current)</td>
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<td>- Dairy Products (current)</td>
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<td>Trade Weighted Exchange Rate Index (current)</td>
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<tr>
<td>Short-Run Consumer Price</td>
<td>Change in Consumer Prices (80% of CPI regimen)</td>
<td>Deviation of CPI from estimated long-run value (lagged)</td>
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<td>Equation</td>
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<td>Change in Producer Input Prices (current)</td>
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<td>Change in Wage Rate (lagged)</td>
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<td>- Dairy Products (current)</td>
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<td>Change in Retail Sales (lagged)</td>
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<td>- Depreciations (current)</td>
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does not incorporate a long-run equation for producer input prices, which could be considered an econometric deficiency. As far as the differences in the significance of the various influences on the CPI (through direct and indirect channels) are concerned, the table below shows the percentage changes in the CPI in the long run that would be associated with a 1 percent change in the respective variables that enter the equation system as major influences on the CPI.

<table>
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<tr>
<th>Long-Run CPI Elasticity</th>
<th>Old System</th>
<th>New System</th>
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<tbody>
<tr>
<td>Unit Labour Costs</td>
<td>0.48</td>
<td>0.50</td>
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<tr>
<td>World Export Prices</td>
<td>0.25</td>
<td>0.08</td>
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<tr>
<td>World Import Prices</td>
<td>0.16</td>
<td>0.21</td>
</tr>
<tr>
<td>Nominal Exchange Rate (TWI)</td>
<td>-0.41</td>
<td>-0.29</td>
</tr>
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</table>

It should be noted that the equations contain lag structures, which implies that the long-run effects may take more than one year to come through. Thus, the coefficients in the table above cannot necessarily be interpreted as contributions to the annual inflation rate for a particular year.

Some of the CPI components that are excluded from the CPI definition used in the latest equation system are responsive to exchange rate movements. Accounting for that factor, the estimate of the pass-through coefficient changes to -0.32. Overall, apart from more plausible relative contributions from export and import prices, the estimated total influence of external prices in the new equation system is considerably less than before. This is consistent with concerns that the exchange rate pass-through coefficient included in the previous equation system of -0.4 was too high. Some observers have argued for a coefficient of significantly less than even -0.3, based largely on evidence from the early 1990s when the domestic economy was in a weak state. However, it should be remembered that an estimated low exchange rate pass-through in such a situation may just reflect the influences of other variables on inflation (such as margin variations), which are being incorporated elsewhere in the Bank’s equation system.

Further differences between the previous set of equations and the one described above include an asymmetry in the dynamics of the exchange rate pass-through to consumer prices. The effect of a depreciation has been estimated to feed through somewhat faster than that of an appreciation. In addition, a change in world prices has been estimated to affect the CPI faster than a corresponding change in the nominal exchange rate - possibly due to the perception that price changes are permanent, while there usually is a significant probability that exchange rate movements may be reversed. In the long-run, however, the respective effects are the same. A further feature of the new equation

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5 The relative contributions from export and import prices in the new equation system are more plausible, given the relative weights of the CPI components that are responsive to the respective external price movements. The significant change in the relative size of the coefficients may be due to the fact that export and import prices display a high degree of correlation over time, which may have dimmed the precision of the estimates in the previous equation system.
system is the disaggregated modelling of the export and import price effects. This is useful, given the distinctly different determinants of price changes in the numerous categories of export and import goods and the different degrees of influence that those categories have on CPI inflation.

The new equations explicitly capture the effect of changes in producer and distribution sector profit margins on the CPI. Given that these variables are not directly observable, variables that reflect demand pressures, like capacity utilisation, retail sales and stock levels, are used as proxies for the scope for producers and the distribution sector to increase margins. Changes in profit margins are of a cyclical nature. During an upturn, increasing capacity utilisation and sales, combined with falling stock levels, usually cause a widening in profit margins. This is partially offset by cyclical increases in productivity. During a downturn, these influences are reversed, resulting in a narrowing of profit margins and, hence, a negative contribution to inflation. The importance of capturing profit margin effects properly is underlined by the fact that they are estimated to be the single biggest contributor to CPI inflation at present.

In summary, although the new equation system does not explicitly incorporate a long-run relationship that determines producer input prices, the system is viewed as being econometrically superior to the previous equations which had various other deficiencies. Furthermore, the new long-run coefficients for external prices are more plausible and the equations capture important influences on the CPI (such as profit margins) that had not been modelled successfully in the past.

Exogenous Assumptions

Since the Bank currently uses a price equation system that is not formally tied in to an economy-wide macroeconomic model, assumptions not only have to be made with respect to external price changes, but also to capture the influences of real economy developments on the price system. The latter affect wages and productivity, as well as profit margins. Without a formal link to a macroeconomic model, the incorporation of the Bank’s real sector forecasts into the process of forming the assumptions that drive the price system requires a significant degree of judgemental input. However, even with a comprehensive macroeconomic model, judgement is usually required to adjust some of the estimated linkages between economic variables. While those linkages have been found to hold on average over a long period of time, they may be considered too strong or too weak on particular occasions on the basis of further information that cannot be formally incorporated into the model.

The ongoing monitoring of various price indices and inflation indicators is an essential part of determining the necessary assumptions. Regular inflation forecasts are prepared once a quarter - the same frequency with which most price indices and indicators are published. This ensures that a full set of observations becomes available between forecast rounds, providing the opportunity for a comprehensive review of the previous set of assumptions. If the most recent actual data proves inconsistent with those assumptions, it has to be assessed whether this is due purely to timing factors or whether it is an indication of a change in trend in a particular variable.

Apart from the review of variables that are of relevance to specific assumptions, the analysis of the most recent actual CPI data provides useful background information for the overall process of generating a set of assumptions. Apart from the aggregate CPI,
Statistics New Zealand provides information on all 333 CPI components, which are aggregated into eight main sub-groups. In order to obtain a measure of underlying inflation, the Bank adjusts the official information on aggregate CPI inflation for the influence of changes in interest rates and for significant one-off price shocks that are outside the control of monetary policy. Furthermore, the Bank disaggregates the official CPI into the categories of goods and services, and, alternatively, into tradeables and non-tradeables, in order to identify whether broad categories of CPI components show different inflation patterns.

Another source of general background information is anecdotal evidence gathered during the Bank’s regular visits of businesses around New Zealand. Information about cost pressures and pricing intentions in the various industries is analysed carefully and integrated into the specific exogenous assumptions as appropriate.

**Unit Labour Cost Assumption**

Labour (wage and non-wage) costs and productivity trends determine changes in unit labour costs. Official information on labour cost trends is provided by the Quarterly Employment Survey (QES), which records average hourly ordinary and overtime wage rates, and the Prevaling Weekly Wage Rate Index, which has recently been superseded by a new Labour Cost Index. The latter two indices measure changes in remuneration for defined job descriptions, while the QES data, in addition, captures the effects of compositional changes within the total pool of jobs in the economy.

Both the QES measure and the Labour Cost Index can be analysed at a sectoral level. In addition, the Labour Cost Index provides a breakdown according to occupation, which enables the analysis of relative wage movements. A further difference between the two measures is the wider coverage of the Labour Cost Index, not only with respect to sectors of the economy, but also regarding non-wage costs incurred by employers. A general shortcoming of official labour market data is the non-availability of information on bonus payments to employees, which are becoming an increasingly important part of overall remuneration and labour costs.

Given information about recent labour cost trends, the main determinant of the assumption for the forecast track is generally the real economy outlook, which influences changes in employment conditions and trends in unemployment. Past relationships between real economy developments and real wage movements are not a good guide to current trends, given that factors such as the introduction of the Employment Contracts Act have significantly changed wage setting behaviour. This is of particular relevance, for instance, to the phenomenon of skill shortages, which - as indicated by the graph below - has, in the past, led to generalised wage inflation with an average lag of five

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6 Main CPI groups: Food; Housing; Household Operation; Apparel; Transportation; Tobacco Products and Alcoholic Drinks; Personal and Health Care; Recreation, Education and Generalised Credit.
7 The criterion for the distinction between tradeables and non-tradeables is the degree to which a particular good or service is subject to international competition.
8 Other information sources include a survey of collective employment contracts lodged with the Department of Labour, as well as a number of private sector surveys on wage movements. However, the interpretability of the information with respect to general wage trends is limited, due to the lack of necessary adjustments to raw data or inappropriate sampling methods.
9 Non-wage costs measured by the Labour Cost Index include the cost of annual leave and statutory holidays, superannuation contributions, ACC employer premiums, medical insurance, motor vehicles for private use, and loans at preferential interest rates.

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quarters. This relationship appears to have broken down, with relatively high rates of wage increases so far having been confined to those occupations for which shortages exist. Nevertheless, the skill shortage measure is a useful indicator of potential wage pressures.

Another indicator that has been used as input into the labour cost assumption is the correlation between the Prevailing Weekly Wage Rate Index and business expectations of changes in the index twelve months ahead, as recorded by the Reserve Bank’s Survey of Expectations. It remains to be seen whether the same correlation will exist between the expectations series and the new Labour Cost Index.

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The skill shortage variable is the net number of respondents who perceive it to have become more difficult to find skilled labour, as reported by the Quarterly Survey of Business Opinion.
Movements in labour productivity, the other determinant of unit labour costs, can be decomposed into a trend component and a cyclical component. Research suggests that price setting behaviour is usually only affected by changes in trend productivity, with cyclical variations leading to temporary expansions or compressions of profit margins. Therefore, trend productivity is the relevant variable for the Bank’s unit labour cost definition. It has been found that a 12 quarter moving average appropriately captures past trend movements, as it does not display any cyclical fluctuations. Due to the averaging process, the measure displays a significant degree of inertia, and, given that the medium-term forecast covers three years at the most, usually only minor and gradual changes in the trend growth rate of productivity are assumed.

The trend productivity outlook has implications for the wage assumption, as it provides a reference path for medium-term real wage movements. With a flexible labour market and decentralised wage setting, a plausible equilibrium relationship would be that real wages increase at the same rate as trend labour productivity. However, the adoption of such an equilibrium assumption may not be appropriate if, for instance, the real economy outlook is for continued high rates of unemployment (suggesting disequilibrium in the labour market) or if skill shortages indicate a relative scarcity of labour, which may suggest that the labour share of income is not at a sustainable level at the time of the forecast.

Export Price Assumption
The official Export Price Index contains disaggregated information about recent price movements in the various export categories. Furthermore, the ANZ Commodity Price Index provides more timely information with respect to prices of agricultural exports.

The dominance of New Zealand exports by a few large commodity groups (dairy, meat, wool, forestry) and the existence of few key players or centralised exporting structures in those markets offers an advantage from a forecasting perspective. Comprehensive and high quality information about aggregate price trends and expectations can be obtained from a few well informed industry sources, such as the Dairy Board and the Meat and Wool Board’s Economic Service, as well as some official institutions, such as the Ministry of Agriculture and Fisheries and the Ministry of Forestry.

With respect to export prices for manufactured goods, the Bank uses producer price forecasts for New Zealand’s main trading partners in this area as a guide. Those forecasts are obtained from various official and private sector sources within the respective countries, or from the international ‘Consensus Forecasts’ publication.

Import Price Assumption
The Import Price Index, which is the official source of information about recent trends, displays a significant degree of volatility. This makes the interpretation of individual quarterly price movements difficult, and suggests the use of two or three quarter moving averages in order to assess general import price trends.¹¹

¹¹ The volatility problem appears to be related to the fact that the import price index does not measure the change in the cost of a constant bundle of goods, allowing potentially significant compositional effects to alter the index.
As far as import price forecasts are concerned, Reserve Bank research has shown that foreign consumer prices are not a good guide to world prices of New Zealand’s imports. Instead, movements in producer and export prices of New Zealand’s main trading partners appear to be more relevant. In particular, changes in United States producer prices and Japanese wholesale prices bear a fairly close relationship to the world price of New Zealand’s imports. A weighted average of international forecasts for those prices series are used as a guide to determine the forecast assumptions. A separate assumption is made for oil prices, which relies on specific industry and commodity market information.

**Profit Margins Assumption**

As indicated above, cyclical variables, such as the rate of capacity utilisation, retail sales and stock levels, have been found to be good indicators of changes in profit margins. Given that those variables reflect the strength of economic demand conditions, the margins assumptions underlying the CPI forecast are a direct function of the aggregate outlook for the real economy.

The difference between the net number of manufacturers expecting to increase selling prices and those who expect an increase in costs, as reported in the Quarterly Survey of Business Opinion (QSBO), appears to be a reasonable short-term indicator of profit margin trends. This variable has historically been correlated with underlying inflation and is used as an indicator of the direction of change in margins rather than of exact magnitudes.

![Graph showing QSBO: Cost and Selling Price Expectations](image)

Source: NZER, Reserve Bank.

12 "What is the Appropriate Foreign Price Indicator of New Zealand’s Import Prices?", Ian Corfield and Ray Brooks, Reserve Bank of New Zealand Discussion Paper G92/10.

13 A Reserve Bank study ("Does Demand Affect Markups?", David Rae and Jason Wong, Reserve Bank of New Zealand Discussion Paper G92/16) has estimated that the change in the CPI arising from producer margins could be as much as 1 percent from the trough to the peak of a business cycle (i.e. spread over around three years).
Nominal Exchange Rate Assumption
Over the last few years, the Reserve Bank has adopted the practice of basing its inflation forecasts on the technical assumption of a constant value of the trade weighted nominal exchange rate index over the forecast horizon, at around the average level that prevailed during the months preceding the forecasts. While such an assumption has the advantage of clarity in distinguishing exchange rate and other influences on inflation, it may insert a bias into the forecasts. For example, if domestic rates of inflation are less than those in the trading partner countries, the assumption of a constant exchange rate would lead to an upward bias, given that such an inflation differential is usually associated with an exchange rate appreciation.

In a case where the combination of non-exchange rate influences suggested an inflation track that moved outside the 0-2 percent target range, the technical assumption of a flat nominal exchange rate could be particularly misleading. In the absence of a market-driven exchange rate adjustment in line with international inflation differentials, or in cases where such an adjustment is not sufficient, a Reserve Bank response, or more likely the expectation thereof by the financial markets, would lead to interest and exchange rate changes in a way that would prevent inflation from deviating from the target range. In addition, where such consequential adjustments were likely, they could be of a magnitude sufficient to affect the other assumptions underlying the inflation forecast (i.e. unit labour costs and margins). Therefore, in order to provide guidance as to the Bank’s view on how those other assumptions would alter, it could be preferable in that case to adopt an assumption that incorporated some adjustment in the exchange rate over time.

Modifications to the Baseline Outlook: The Use of Supplementary Forecasting Tools
The foregoing assumptions are inserted into the equation system in order to generate a provisional medium-term track for the relevant part of the CPI regimen, with exogenous assumptions required for the outlook for the remaining 20 percent of CPI components. Given the nature of the items excluded from the CPI definition used in the equation (as discussed earlier), the aggregate forecast for the latter part of the CPI regimen is based on specific information and expectations about the increase in government charges, an assumption about expected movements in interest rates, information on weather-related influences on the price of fruit and vegetables, etc. The weighted combination of the equation-generated and the assumption-generated forecasts yields a baseline track for the medium-term outlook, which may then be subject to the modifications outlined below. The determination of the magnitude of such modifications involves judgemental input.

Components Forecasts
For the first two quarters of the forecast period, the baseline forecast generated by the general equation system are often overridden by components forecasts. Components forecasts are based on specific information about price changes in the various CPI components. Such information can result from specific announcements (e.g. changes in electricity prices or airfares), leading indicator relationships, or the analysis of regulari-
ties in the quarterly pattern of price changes. For those components where no specific information exists, the baseline forecast is used as the standard assumption for the outlook.

**Short-Term Leading Indicators**
A range of price variables provide short-term leading indicator information of changes in the CPI components and are, therefore, closely monitored:

a. **Food Price Index**: This is a sub-index of the CPI. Given its significant weight in the CPI regimen (around 18 percent) and its monthly publication, the Food Price Index provides useful advance information on changes in one of the main CPI components.

b. **Producer Output Price Index (PPIO)**: The agriculture and forestry components of the PPIO are good one quarter leading indicators of the meat and timber components in the CPI. Furthermore, the PPIO construction component two quarters previous is correlated with the corresponding component in the CPI.

c. **Export Price Index**: This index is a one quarter leading indicator of the agriculture and timber components of the PPIO, due to the dominance of commodities in the export price index. Given the one quarter leading indicator characteristic of these PPIO components with respect to the CPI, the export price index has also been found to be a two quarter leading indicator of price changes of some of the corresponding tradeable goods components included in the CPI.

d. **ANZ Commodity Price Index**: One quarter ahead information on commodity price influences on the Export Price Index are provided by this monthly index. Given the leading indicator relationships described above, the ANZ index is an indicator of commodity price influences on the CPI of up to three quarters ahead.

e. **Capital Goods Price Index**: The transport component provides a one quarter leading indicator of used car prices recorded in the CPI.

f. **Import Price Index**: This index is a two quarter leading indicator of some tradeable goods prices recorded in the CPI (appliances, etc.). However, as pointed out before, the volatility in the import price index makes the interpretation of individual quarterly observations sometimes difficult.

Numerous other direct and indirect contemporaneous relationships exists between the CPI and the Retail Trade Deflator, the Capital Goods Price Index and the Farm Expenditure Index. Even though these price indices are generally not leading indicators, they are monitored closely. Should price movements recorded in those indices not equally be recorded in the CPI in the same quarter, this may indicate future consumer price changes. Similar considerations apply in cases where the usual leading indicator relationships described above do not hold for particular observations.
Regularities in Quarterly Changes
There is evidence of a small degree of seasonality in the quarterly CPI observations, driven in particular by the ‘Apparel’ sub-group of the CPI regimen, where price reductions for stock clearance reasons usually occur in the March and September quarters, while the June and December quarters experience price increases. Furthermore, local authority rate increases occur in the September and December quarters, and Tobacco and Alcohol price changes are recorded mainly in the December quarters, due to regular tax increases.

Further analysis on the regularity of quarterly price movements has been provided by a recent Reserve Bank study, which showed that quarterly price changes are usually clustered around zero, with large changes for some items causing quarterly CPI inflation rates to deviate from zero. Some services and non-tradeable goods appear to display more infrequent, but large, price changes. Thus past changes in those particular components can be analysed to infer likely movements in future quarters.

Expectations Surveys and Leading Indicator Analysis
Price expectations surveys are indicators of individuals’ or companies’ price or price setting expectations (for their own business or within their industry). While expectations can suffer somewhat from wrong perceptions of actual inflation, trends and turning points are nevertheless useful indicators. The monthly National Bank Business Outlook Survey, the quarterly Reserve Bank Survey of Expectations, the quarterly Marketscope Survey of Household Inflation Expectations, the quarterly Dun and Bradstreet Survey of Business Expectations, and the Quarterly Survey of Business Opinion are the main sources of information.

Leading indicator analysis provides a systematic framework for the interpretation of expectations data. However, most of the series listed above show either very weak correlation with CPI inflation, or appear to be coincident indicators.

Information on actual and expected selling prices, as recorded by the QSBO, has proven to be more useful. The economy-wide series, as well as the sectoral series, all show reasonably good leading indicator properties with respect to CPI inflation a few quarters ahead. Furthermore, the regression of a core inflation measure on earlier expected selling price data for the manufacturing sector displays satisfactory statistical properties. The historical relationship would suggest that regression-based results could be used as indicators of the magnitudes of future CPI inflation - unlike most leading indicator relationships, which only provide information on general trends and turning points.

Other variables apart from expectations data that have displayed a close correlation with CPI inflation in the past are annual average changes in the production measure of Gross Domestic Product (GDP) and the QSBO measure of capacity utilisation. The latter is now explicitly factored into the baseline forecast via the new equation system. During the 1980s, the average lag between changes in GDP or the capacity utilisation index and CPI inflation was only one quarter. However, this relationship appears to have broken down as inflation has been reduced and as price stability has been achieved. The annual

inflation rate has remained within the 0-2 percent target band since the end of 1991, while GDP growth and capacity utilisation have increased significantly. Nevertheless, the effect of the structural reforms on the New Zealand economy during a sustained recovery are largely unknown and care must be taken in discounting past relationships. In fact, evidence of a continuing relationship between the level of capacity utilisation and the rate of change in inflation suggests that real economy developments continue to have an influence on inflation.
Disaggregated CPI Equations
The Reserve Bank has recently estimated a system of structural equations for various CPI components which cover nearly half of the CPI regimen: Meat, Fish and Poultry; Dairy Products and Eggs; Other Food; Market Dwelling Rentals; Housing Construction and Maintenance; Household Operation; Apparel; Personal Goods and Services. Other components were not estimated because the relevant price changes are usually not market driven (e.g. government charges) or they are difficult to model (for example, weather influences on the price of fresh fruit and vegetables). The standard structure of the various equations contains sector-specific variables, such as unit labour costs and world prices, as well as the TWI.

While the high number of sector specific variables would suggest that such a disaggregated system should be superior to an aggregate equation in explaining price movements, small influences that are significant at an economy-wide level, may not be picked up in the individual equations (e.g. petrol price changes). In addition, there may be a loss in forecasting accuracy by having to make assumptions with respect to a high number of sector specific variables. In combination, these factors may explain why comparisons of the performance of the sum of the disaggregated specifications and an equivalent aggregate equation have not shown the former to be superior.

Nevertheless, the disaggregated equation system may be a useful tool for checks on the baseline forecast, and the components forecasts in particular. Although the overall performance may not have been superior when tested on historical data, significant deviations relative to the baseline track generated by the core equation system will be

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worthwhile to investigate. Depending on the cause of the deviation, a modification of
the baseline forecast track might result.

Vector Autoregressive Models
VAR models are non-theoretical models which do not contain behavioural relationships.
Only the observed time series history of the data is used to forecast economic variables.
In a VAR model, all variables are specified as a function of their own history and past
values of all the other variables in the system.

Overseas studies have shown that VAR models can be as successful at forecasting as
systems of structural equations. This has been confirmed in the New Zealand case, where
the Bank has developed a type of vector autoregressive model, known as Bayesian
Vector Autoregressive Model (BVAR). Over the period 1988-1992, this BVAR model
would have been marginally more accurate than the official forecasts of inflation of up
to five quarters ahead.16

The BVAR model that is currently used for forecasting purposes focuses on a measure
of core inflation rather than the official CPI. Other variables are the Producer Price Index
(Inputs), the private sector hourly wage rate, productivity, the Import Price Index, and
the QSBO measure of capacity utilisation. It has been found that, while the BVAR model
was quite successful in forecasting over the disinflation period, over the last year it has
been more useful in indicating broad trends in inflation rather than predicting exact
magnitudes of quarterly changes in the CPI. The BVAR model thus provides a useful
tool for assessing the general path of the inflation outlook generated by the structural
equations, rather than an alternative forecasting approach.

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16 “Forecasting Inflation and Real GDP: Bayesian VAR Models of the New Zealand Economy”, Jason Wong and Peter
Iolly, Reserve Bank of New Zealand Discussion Paper G93/3.

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Summary
This article has described the current methods used by the Reserve Bank to generate regular medium-term inflation forecasts. A set of structural price equations is at the core of the forecasting system, and is supplemented by leading indicator analysis, a vector autoregressive model, a system of disaggregated CPI equations, and the use of anecdotal evidence with respect to specific CPI components.

In order to enhance the quality of this forecasting framework, the Bank is currently investigating the possibility of a renewed closer integration of the price equations into a general macroeconomic model to ensure consistency over time between real economy and inflation forecasts. Although the Reserve Bank’s Model XII provides such a comprehensive framework, it has not performed well as an inflation forecasting tool. An alternative framework would need to be developed.