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Abstract

This paper examines the relationship between the general price level and the relative price of fuel by measuring correlation from VAR forecast errors. The results suggest a significant positive correlation between quarterly changes in the relative price of fuel and the CPI, at least in the short to medium term from two to four years. The finding has important implications for measuring the long-term trend in inflation as relative price changes in fuel contain important information about future inflation.

Key words: inflation, oil prices, correlation, VAR

JEL classification: E31, E37

1 Introduction

This paper examines the comovement between the relative price of oil and the general price level represented by the consumer price index. Many policy makers and analysts usually attempt to identify the underlying trend in CPI inflation by excluding certain components subject to large relative price changes, such as fuel and food. The rationale is that fluctuations in the prices of fuel and food are usually transitory and unusual changes are unlikely to be related to the underlying trend in CPI inflation. Some underlying inflation measures, such as the CPI excluding food and energy, systematically remove these components from overall inflation. Other measures, such as the trimmed mean CPI proposed by Bryan and Cecchetti (1994), remove the components experiencing large relative price changes in a given period, with the set of excluded components varying from period to period.

According to classical theory, the price level is determined by money supply and relative prices are determined by real factors. For a given money stock, changes in relative prices increase some nominal prices and decrease others, but will not affect the general price level. Ball and Mankiw (1995) introduce a model in which firms face menu costs and show that large relative price shocks have a large impact on the price level in the short run when some of prices are sticky. Aoki (2001) presents a dynamic optimising model with a flexible-price sector and a sticky-price sector to analyse the effects of relative-price changes on inflation fluctuations and shows that the relatively persistent component of aggregate inflation is affected by expected future changes in relative price changes. It implies that relative price changes may have information of future changes in core inflation.

One implication of frictions in price adjustment on the short to medium run dynamics of inflation is that it may not be desirable to exclude components with big price changes from the CPI since at least in the short term and possibly in the medium term, large relative price changes would affect the general price level. Energy prices are usually identified as a main source of relative price changes, and it is widely believed that oil price shocks at least partially "pass through" into other prices.[1] This paper looks at relative price changes of automotive fuel in Australia by employing a framework proposed by den Haan (2000), which measures comovement with VAR forecast errors. The estimated correlation coefficients in the paper show that in the longer term, well exceed 4 quarters, there exists a positive correlation between the relative price change of fuel and headline inflation. The remaining of the paper is organised as follows. Section 2 discusses the relative price of fuel in Australia since the early 1970s. Section 3 presents the methods and results. The last section concludes the paper.

2 Data and time series properties

The paper uses the Australian Bureau of Statistics (ABS) Consumer Price Index (CPI) as the general price level and the component of automotive fuel in the CPI as the price of fuel[2]. The data start from the third quarter of 1972 and ends in the June quarter of 2005, covering from the 9th to 14th CPI series. Over the sample period, the weight of fuel has been declining gradually, from about 4.8 per cent at September quarter 1976 prices to about 4.6 per cent at June quarter 2005 prices.[3] The decline of the importance of fuel in the CPI basket is due to the expansion of the CPI to include more goods and services and slightly declining expenditure on fuel by households.

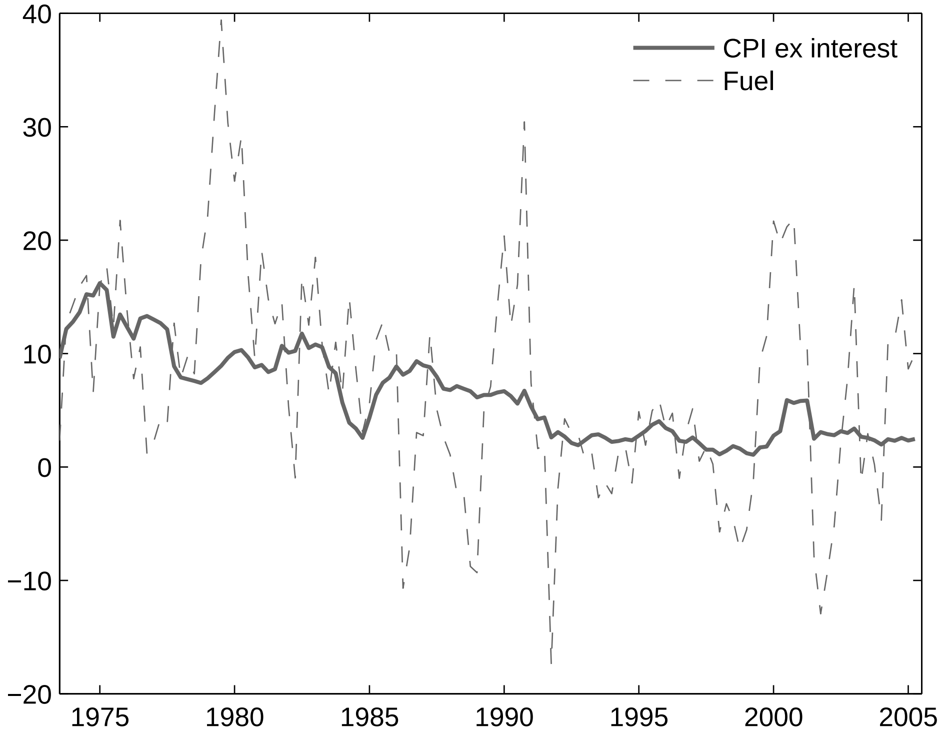
As shown in Figure 1, inflation in fuel prices is much more volatile than CPI inflation and did not fall as much as CPI inflation. While CPI inflation in year-ended terms fell from above 10 per cent in the 1970s to about 3 per cent in 2005, inflation in fuel prices rose significantly in the past few years after falling in the 1990s. From 1973 to 2005, average annual inflation in fuel prices is 7.3 per cent, 1 percentage point higher than that of the general price level. As a result, the relative price of fuel rose substantially

[1] See, for example, Hooker (2002) for an examination of oil prices in the context of US inflation Philips curves.

[2] The CPI series used has been re-compiled to exclude interest charges, which the ABS introduced from 1987 to mid-1998.

[3] The underlying quantity weights for CPI expenditure classes are updated at approximately five yearly intervals with the timing generally linked to the availability of Household Expenditure Survey data. A new CPI series introduces new weights resulting from these updates.

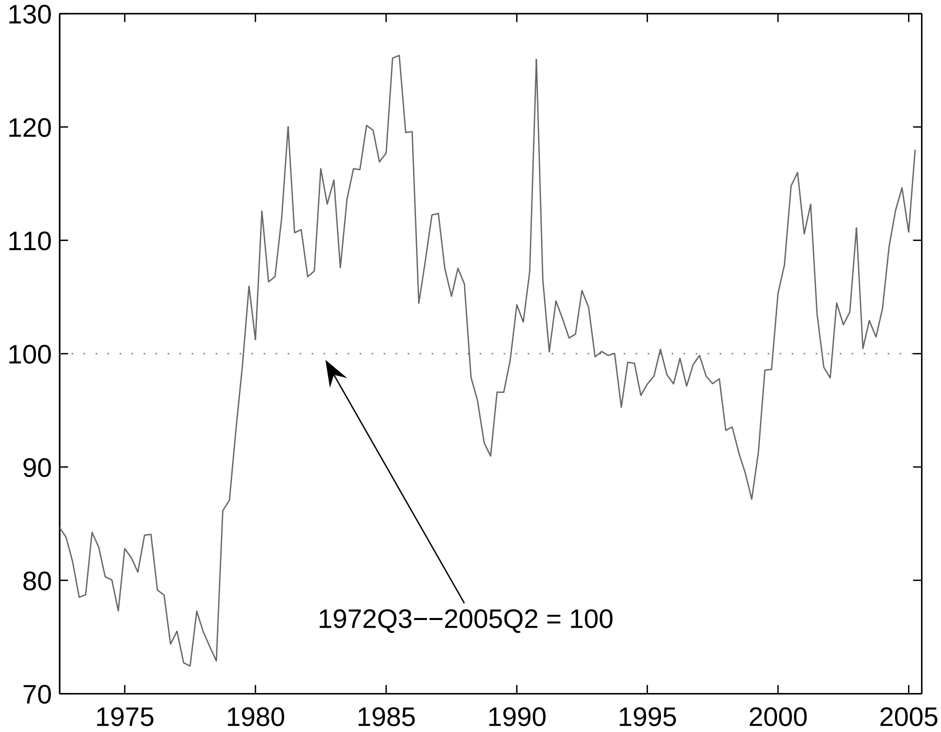
Figure 1: Year-ended Inflation (per cent) of CPI and fuel: September 1973 – June 2005



in the past thirty years. Figure 2 shows that while there are few large swings caused by events such as two Gulf wars, the relative price of fuel has risen by about 50 per cent in the past three decades. While higher than average in the 1980s and the first five years of the new millennium, the relative price of fuel was mostly below average in the 1970s and 1990s, indicating that fuel price changes tend to be persistent over the sample period.

Table 1 reports basic statistics of the annualised rates of quarterly changes in the general price level and the relative price of fuel, defined as ΔP and ΔF respectively, and the correlation of the two series at different leads and lags in two sample periods. The shorter period 1982–2005 has a common start and end level of the relative price of fuel. The correlation coefficients indicate that an increase in the relative price of fuel would push up the general price level, but the rise in the general price level tends to be corrected in the following quarter. The correlation coefficients between the two series are generally insignificant and it is hard to discover any interesting patterns. The table also suggests that in the shorter sample starting from 1982, the gap between annual inflation

Figure 2: Relative price of fuel: September 1972 – June 2005



in fuel prices and the CPI falls to 0.4 percentage points per year, but the volatility of fuel prices is almost the same as in the full sample.

3 Measuring comovement with VAR forecast errors

Following den Haan (2000), the paper calculates correlation coefficients of forecast errors at different forecast horizons, obtained from estimation of various specifications of the

Table 1: Traditional correlation between relative price of fuel and general price level

	Corr $(\Delta F_t, \Delta P_{t+k})$					ΔF	ΔP
	-2	-1	0	1	2	Average % (std. dev.)	
1973-2005	-0.06	-0.05	0.18*	-0.11*	-0.05	1.11 (19.4)	6.23 (4.65)
1982-2005	-0.13	-0.02	0.27*	-0.21*	-0.10	0.40 (18.8)	4.42 (3.27)

Note: an asterisk indicates a coefficient is significantly different from zero using a 5 per cent one-side test based on the VARHAC procedure described in den Haan and Levin (1997). Growth rates are expressed on an annual basis.

following VAR model:

$$Y_t = A + Bt + Ct^2 + \sum_{j=1}^{L} D_j Y_{t-p} + \varepsilon_t \tag{1}$$

where Y_t is an $m \times 1$ vector that includes the changes in the relative price of fuel and the CPI (ΔF_t and ΔP_t, respectively); A, B and C are $m \times 1$ vectors of constants; D_j is an $m \times m$ matrix of auto-regressive coefficients at lag j and the totel number of lags included is equal to L. ε_t is an $m \times 1$ vector of residuals that are assumed to be serially uncorrelated but can be correlated with each other. The K-period ahead forecast errors for fuel and non-fuel inflation from the VAR are defined as follows:

$$e^{\Delta F}_{t+K,t} = \Delta F_{t+K} - E_t \Delta F_{t+K} \tag{2}$$

$$e^{\Delta P}_{t+K,t} = \Delta P_{t+K} - E_t \Delta P_{t+K} \tag{3}$$

The correlation coefficient between $e^{\Delta F}_{t+K,t}$ and $e^{\Delta P}_{t+K,t}$ is denoted by $Corr(K)$. As shown in the general formulation of the estimation Eq. (1), this model allows for a number of dynamic characteristics, including a trend and/or a quadratic trend, of the series that are being modelled. As noted by den Haan, no assumptions on the order of integration of Y_t have to be made. It is possible that Y_t contains stationary as well as integrated processes. $Corr(K)$ can still be estimated consistently for fixed K, provided that the lag order is large enough to guarantee that ε_t is not integrated.

The paper first estimate a bivariate VAR that includes the percentage changes in the relative price of fuel and the general price level, then estimates a multivariate VAR that includes percentage changes in crude oil prices, real GDP and money supply, and changes in the unemployment rate as additional variables. Since these variables have been shown to be important for long-run and short-run behaviour of inflation, it would be appropriate to see if they affect the relationship between the relative price of fuel and the general price level. While unit root tests such as the Augmented Dickey-Fuller test reject the unit root null hypothesis for the variables in the sample periods, there is evidence that some of the variables may be a unit root process. Therefore, each VAR

Table 2: Characteristics of the estimated VARs

Sample period	Unit root imposed	No. of variables	No. of lags	Linear trend	Quadratic trend
1972Q4–2005Q2	No	2	2	Yes	Yes
	No	6	1	Yes	No
	Yes	2	3	No	No
	Yes	6	4	No	No
1982Q1–2005Q2	No	2	1	Yes	Yes
	No	6	8	Yes	Yes
	Yes	2	3	No	No
	Yes	6	8	No	No

has been estimated twice: with or without imposing a unit root in the estimation. The characteristics of the VAR models estimated over two sample periods are summarised in Table 2. The lag lengths and inclusion of linear and quadratic trends are based on the Akaike information criterion.[4]

Since the calculated correlation coefficients are based on the estimated VARs, they are subject to sampling variation. 90 per cent confidence intervals are calculated by using bootstrap methods. Each estimated VAR and its bootstrapped errors generate 2,500 repetitions. A set of correlation coefficients is estimated for each repetition and confidence intervals can then be obtained. The correlation coefficients based on VAR forecast errors along with their 90 per cent confidence intervals are plotted in Figures 3 and 4. While Figure 3 plots these coefficients for the sample period 1972Q4 to 2005Q2, Figure 4 plots them for the shorter sample period starting from 1982.

For the full sample period, when a unit root is imposed in the estimation of the VAR, the correlation coefficients are significantly positive at all horizons. Without imposing a unit root in the estimation of the VAR, the correlation coefficients tend to be not significant after 2 to 4 years and they are also smaller than those when estimated with a unit root imposed. In the shorter sample period from 1982 to 2005, the correlation coefficients follow similar paths in the full sample, but are bigger. They are significantly positive even when a unit root is imposed in the estimation of the VAR.

Given the widespread view that relative price changes are caused by temporary

[4]A lag length of eight is also used to estimate all these models and the results obtained are similar to those presented in the paper.

Figure 3: Correlation coefficients based on VAR forecast errors: 1972Q4–2005Q2

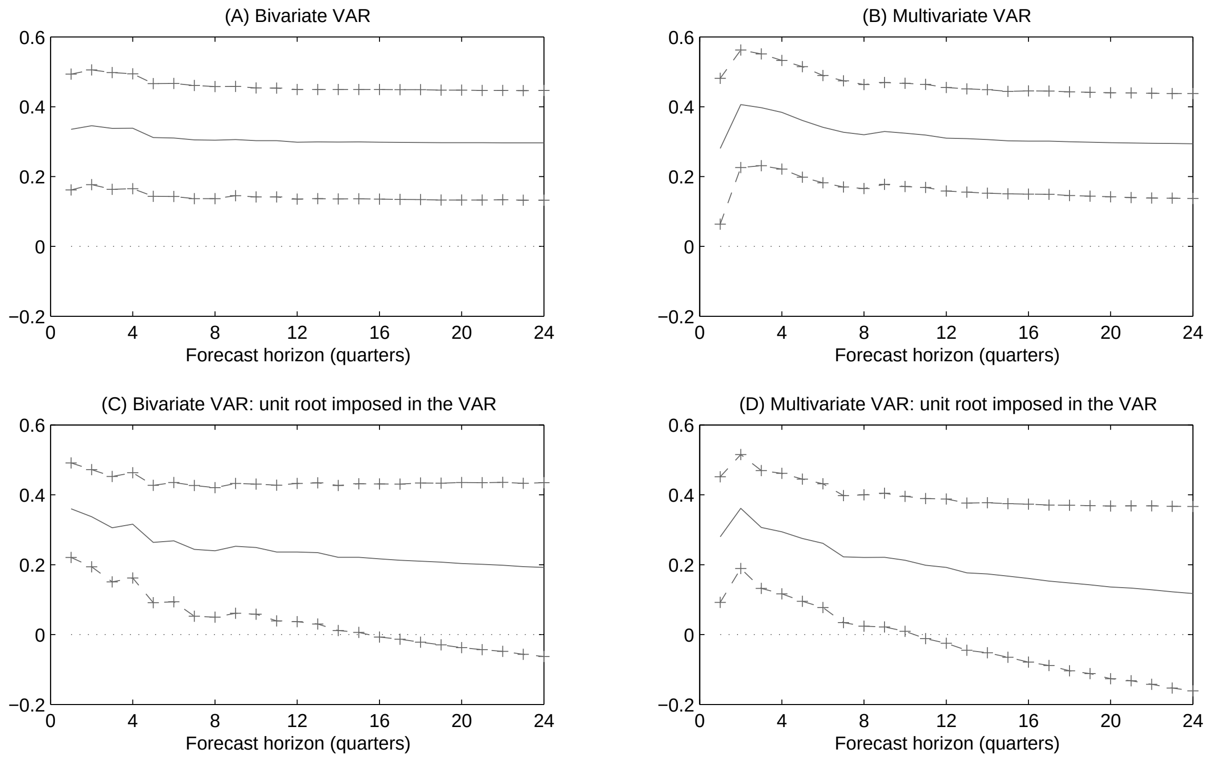
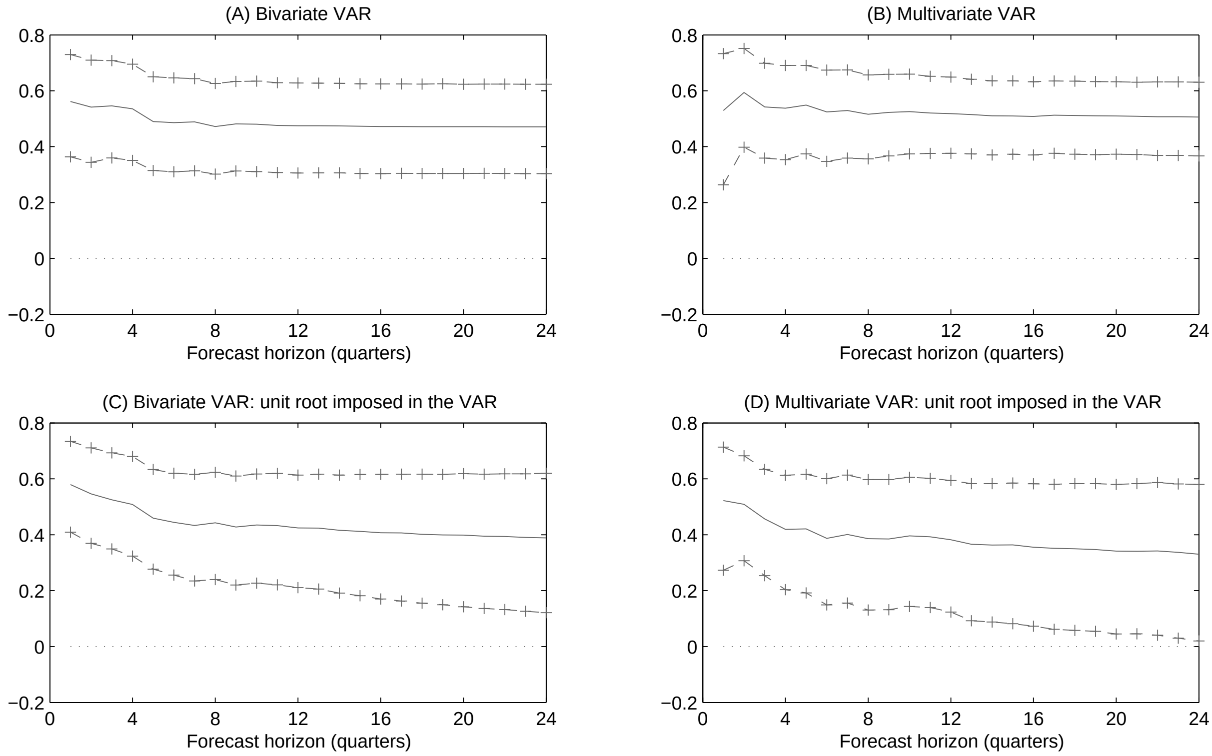


Figure 4: Correlation coefficients based on VAR forecast errors: 1982Q1–2005Q2



disturbances in the individual markets and therefore the positive relationship between inflation in the general price level and relative price changes would at best be short-lived, the result presented here is interesting and has far-reaching implications for theories that are needed to explain such relationship. One possible explanation for the positive relationship between relative price changes of fuel and inflation in the general price level in the short to medium term is that oil has an important impact on the process of inflation. The long-run inflation rate is governed by monetary policy, but in the short to medium term, oil prices could make a substantial contribution to inflation and the impact could be long-lasting. As shown by many authors, increases in oil prices have been highly correlated with, or have even contributed to economic downturns.[5] Higher oil prices may lead to higher inflation in the general price level, if the central bank does not restrain demand when supply is adversely affected.

Alternatively, the positive relationship between relative price changes in fuel and inflation could be explained by technology progress. In the past three decades, technology progress and a decrease in regulations and other market distortions have increased productivity, which have been credited for increasing output and and keeping inflation low. Technological innovations may have also increased the efficient use of oil in the economy and decreased the dependency of the economy on oil, slowing down relative price changes of oil even when the supply of oil is at or near capacity. If these changes in productivity are persistent it may very well be that the movements in the relative price of fuel and the general price level, captured by the VAR forecast errors at all forecast horizons, are positively related.

4 Conclusion

This paper has examined the relationship between general inflation and relative price changes of fuel by estimating the correlation coefficients based on VAR forecast errors. The results suggest that the positive correlation between the relative price of fuel and

[5] See a survey by Hamilton (2005).

the general price level seems to hold at least in the short to medium term (from two to four years). The finding has important implications for inflation measurement: it may not be wise to exclude energy from inflation when estimating the underlying trend in inflation because the relative price of oil contains important information about general inflation.

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