NEW KEYNESIAN MODELS AND THE TEST OF KYDLAND AND PRESCOTT

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ABSTRACT

A benchmark New Keynesian model is assessed using Real Business Cycle methods. This paper evaluates New Keynesian models using RBC methods for a number of key macroeconomic variables to determine whether these models are able to replicate the comovements found in the data. Its main findings are that the New Keynesian model and alternative variants struggle to replicate key business cycle properties for nominal variables. This result is poses a challenge for models currently used for monetary policy and business cycle analysis and is puzzling, given their success in replicating impulse response functions.

JEL Classification: E32, E52, E58

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1. Introduction.

Beginning with Kydland and Prescott (1982) real business cycle (RBC) macroeconomics has led to sweeping changes in the way macroeconomics is conducted. There is greater emphasis on building models with strong microeconomic foundations, with the aim of overcoming the Lucas critique; the supply side was considered the economy's driving force and traditional econometric techniques were eschewed in favour of a more a-theoretical approach that attempted to replicate the data's second moments to its empirical counterpart.

The current paradigm in macroeconomics, New Keynesian macroeconomics[2], builds on many elements from RBC theory, but has placed greater emphasis on nominal rigidities and the nominal causes of output fluctuations – so that consequently, less importance has been attached to technology shocks – and models are often evaluated by their ability to replicate the impulse responses obtained from vector autoregressions (VARs). But this focus on the effects of shocks, to the neglect of a model's systematic components, could potentially lead researchers to incorrectly conclude that their model performs well, as only one aspect of the model's characteristics is observed. The traditional assessment procedure used to evaluate RBC models proposed by Kydland and Prescott, which built on the work of Burns and Mitchell (1946), focused on the co movement of variables as the defining features of the business cycle. Nevertheless, this approach has been increasingly discarded due to identification problems. The purpose of this paper is to argue that the RBC model evaluation methodology can still provide useful insights and that this is an area that should not be neglected. Evaluating a model solely on the basis of the cross correlations it yields and the standard deviations of the variables has its

[2] Also called New Neoclassical Synthesis (see Goodfriend and King, 1997).

limitations; simply because a model is able to mimic the data does not mean that it can explain it. As Summers (1986) argued, "Many theories can approximately mimic any given set of facts; that one theory can does not mean that it is even close to right". Indeed, in the context of RBCs, one of the biggest limitations was the ability of many models to mimic the data and the Burns-Mitchell methodology was unable to discriminate alternative models. As King and Plosser (1994) found, one cannot distinguish between a Keynesian (Klein-Goldberger) and an RBC model when using the methods of Burns and Mitchell. As a result, to this author's knowledge, there has been no general attempt to assess sticky price models using the Burns-Mitchell methodology. To the extent that alternative models are able to mimic the data, this exercise will yield few insights. However, if different model specifications result in clearly distinguishable co-movements in the variables, then it is possible to gain additional information on the models that satisfy this minimum of benchmarks. In effect, if matching the data's co-movements is a necessary but not sufficient condition for explaining the data, then sticky price models that are unable to do so can be rejected on the grounds that they do not satisfy this minimum of criteria.

To this author's knowledge, little work has been carried out that applies a general assessment of New Keynesian[3] (NK) models using RBC methods, with particular focus on inflation and nominal interest rates. The purpose of this paper is twofold: to determine whether different NK model variants lead to clearly distinguishable co-movement in the model's variables, and if so, which models are able to replicate the data.

[3] Here New Keynesian models are defined as models that embody nominal rigidities and rational expectations, so that Fuhrer-Moore-type Phillips curves would also be included.

The paper proceeds as follows. Section 2 will present the cyclical characteristics of a small subset of key macroeconomic variables for the US economy that most modern small models generally include, so that the theoretical models can be evaluated using RBC methods. Section 3 will then present a small NK macro model representative of the literature for analysing monetary policy. It will also include endogenous capital so that investment and consumption can be analysed separately. Section 4 discusses the calibrated values used and section 5 then evaluates this benchmark model, as well as also assessing alternative variants commonly found in the literature. Section 6 will then consider the role of technology shocks in NK business cycle models and section 7 concludes.

2. Some Business Cycle Facts.

The study of the stylised facts of economic fluctuations has already been well documented[4]. Therefore this section will provide a brief description of the variables of interest, focusing on a limited number of real and nominal variables that feature prominently in modern monetary policy analysis. These are consumption, output, investment, the inflation rate and the nominal interest rate. Since the relationship between real and nominal variables is likely to be unstable with changes in monetary policy regime - and hence the term "stylised fact" would be inappropriate - this paper will focus on the period 1987:3-2002:2, which covers Greenspan as chairman of the Fed[5]. The data have been de-trended using the HP filter[6] on the grounds that this paper is focusing on

[4] See among others, van Els (1995), Fiorito and Kollintzas (1994) and Millard, Scott and Sensier (1999).
[5] As in Judd and Rudebusch (1998) and Clarida, Galí and Gertler (2000), there are reasons to believe that the Fed's reaction function may be stable across different Fed Chairmen.
[6] With a value of λ=1600.

fluctuations of 32 quarters or less, which is exactly what the HP filter yields, as argued by King and Rebelo (2000); furthermore, using a band pass filter that discards high frequency fluctuations does not change the main conclusions of this paper.

TABLE I

US BUSINESS CYCLE FACTS (1987:3-2002:2)

Variable	σ_x	σ_x/σ_y	ρ_1	t-4	t-3	t-2	t-1	t	t+1	t+2	t+3	t+4
Y	0.99	1	.88	.29	.49	.73	.88	1	.88	.73	.49	.29
C	0.68	0.69	.86	-.06	.15	.39	.60	.77	.81	.77	.63	.46
X	4.07	4.11	.89	.38	.55	.73	.84	.91	.79	.60	.35	.14
PI	1.02	1.03	.48	-.14	-.07	.01	.19	.24	.37	.35	.38	.35
FF	1.87	1.89	.96	.10	.21	.35	.47	.58	.63	.61	.54	.43

Note: Y denotes real GDP; C is real consumption expenditure in nondurable goods and services; X is real private domestic investment and consumption of durable goods. PI denotes the GDP deflator inflation rate and FF is the federal funds rate (both annualised).

The second column presents the standard deviation for each variable, while in the third column these are stated as a proportion of the volatility of output. A standard result is that consumption is less volatile that output and the opposite is the case for investment. ρ_1 denotes the first order autocorrelation coefficient and the remaining columns present the correlation coefficient between each variable (at time *t+i*) with output at date *t*. A large number in (absolute terms) appearing in column t + i (t - i) indicates that the series lags (leads) the cycle by i quarters. If the absolute value of the cross-correlation is highest at i = 0, then the variable will be defined to move contemporaneously with the cycle. Additionally, for the whole sample period the critical value for the correlation coefficients[7] is 0.13. The results from Table I indicate that all variables are procyclical, with investment moving contemporaneously with the cycle and consumption, inflation and the nominal interest rate lagging the cycle.

These results are not new and well known in the RBC literature, but what has not been determined is how well an NK model can fit these facts.

3. A Standard New Keynesian Model.

Most current models used for monetary policy analysis[8] are derived from optimising behaviour that can be simplified into three equations. An expectational IS that relates consumption (or output) to its expected future value and depends negatively on the real rate of interest; a Phillips curve that arises from the presence of nominal rigidities, typically in goods prices á la Calvo and a monetary policy rule that describes the setting of the monetary instrument (the interest rate) either exogenously or as a result of maximising some welfare criterion. The model to be presented in this section embodies all these features, but also allows for endogenous capital, so that there is a role for investment. However, it is well known (Ellison and Scott, 2000) that sticky price models with endogenous capital result in extremely high volatility in the model's variables at high frequency. This result normally arises due to the magnitude of the changes in the real interest rates and the sensitivity of investment to the real interest rate. Because prices are temporarily fixed, a nominal shock has a direct, and large, effect on the real interest rate. This problem does not arise in flexible price models, such as RBCs, because the real

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[7] See McCandless and Weber (1995) or Hoel (1954). The standard deviation of the correlation coefficient can be computed as: $(n-3)^{-\frac{1}{2}}$, where n is the sample size.

[8] Representative among these are Walsh (2003, Ch. 5), Galí (2003) and McCallum and Nelson (1997).

interest rate is only affected by real factors, which results in smaller deviations from its steady state, so that consequently, investment behaves in a manner consistent with the data. As a result of this high volatility in investment it is necessary to posit some restriction, and the model in this section will assume adjustment costs to investment. This model is almost identical to that in Casares and McCallum (2000) and the reader is asked to refer to it for details, where all variables denote deviations from steady state:

$$c_t = E_t c_{t+1} - \sigma^{-1}\left(R_t - E_t \pi_{t+1}\right) \tag{1}$$

$$x_t = \frac{1}{(1+\delta)} E_t x_{t+1} + \gamma\left(\frac{\theta - 1}{\theta} E_t f_{k,t+1} - \left(R_t - E_t \pi_{t+1}\right)\right) + \frac{\delta}{1+\delta} k_t \tag{2}$$

$$f_{k,t} = \bar{f}_k (y_t - k_t) \tag{3}$$

$$k_{t+1} = (1-\delta)k_t + \delta x_t \tag{4}$$

$$y_t = \frac{C}{Y} c_t + \frac{G}{Y} g_t + \left(\frac{X}{Y} + \frac{C(x,k)}{Y}\right) x_t \tag{5}$$

$$\pi_t = \phi_0 E_t \pi_{t+1} + (1-\phi_0)\pi_{t-1} + \phi_1 \tilde{y}_t + \xi_t \tag{6}$$

$$R_t = (1-\mu_3)[\mu_1 \pi_t + \mu_2 \tilde{y}_t] + \mu_3 R_{t-1} + v_t \tag{7}$$

$$\hat{y}_t = z_t + \alpha k_t \quad (8)$$

$$\tilde{y}_t = y_t - \hat{y}_t \quad (9)$$

Equation (1) represents the expectational IS, with σ denoting the coefficient of relative risk aversion[9]. Equation (2) is the investment equation that arises as a result of the presence of investment adjustment costs, where γ is a function of the adjustment cost and θ is the firm's elasticity of demand. Equations (3) and (4) simply represent the marginal product of capital and the transition equation for capital, respectively. Equation (5) is the aggregate resource constraint and equation (6) is a Phillips curve á la Fuhrer and Moore (1995). For robustness analysis this paper will analyse the consequences of varying the parameter ϕ_0, so that the standard New Keynesian Phillips Curve (NKPC) that arises from Calvo pricing will be nested within this framework.

3.2 Monetary Policy

There is a considerable amount of literature on estimating monetary policy reaction functions for the US. Monetary policy in the US can be well characterised by a Taylor-type rule, that is, the monetary policy instrument is a short-term interest rate that reacts to both deviations of inflation from some target value and the output gap, $\tilde{y}_t$[10], with most rules including the lagged interest rate as a source of persistence. Although the actual

[9] Or alternatively in this model, the inverse of the intertemporal elasticity of substitution in consumption.
[10] Defined as the deviation of current ouput from its flexible price level, $\hat{y}_t$.

weights on inflation, the output gap and the lagged interest rate are not stable over time[11], however, but there is reason to believe that they may be stable during the tenure of the same Fed chairman; in our case the Greenspan period will be considered and the particular monetary policy rule will be that of McCallum and Nelson (1999), as shown in equation (7).

It is important to note that the monetary authority reacts to the gap between sticky-price output and its flexible-price counterpart, rather than cyclical output itself. The fact that central banks are aware of this distinction is evident in their publications and speeches where high productivity growth is not regarded as inflationary[12].

One should also note that there are four shocks in this model. Fiscal policy shocks, g_t, enter the IS equation and the more persistent they are, with ρ_g denoting its autocorrelation coefficient, the lower its impact on consumption. Technology shocks, z_t, affect potential output and therefore have a direct effect on the Phillips Curve and the monetary policy rule. Additionally, there are monetary policy shocks, v_t, and cost-push shocks (ξ_t). The latter are important in that they provide a theoretical rationale for the existence of a short-term tradeoff between inflation and output stabilisation, even if it is not clear how this shock originates in the model.

4. Calibration.

The calibrated values are shown in Table II and these are standard in the NK literature, where ρ_z is the autocorrelation of the technology shock (similarly for fiscal policy). δ is

[11] See Clarida, Galí and Gertler (2000).
[12] For a discussion on this issue from a central bank perspective see ECB (2000).

the depreciation rate, set at 10% per annum, σ is set at 5 as in McCallum and Nelson (1999) and justifiable on the grounds that this model includes both consumption and investment. θ (the elasticity of demand) has been set at 6[13] and the volatility of the cost-push shock is the same as in McCallum (2001).

Table II: Calibration	
Parameter	Value
ϕ_0	0.5
ϕ_1	0.05
β	0.995
α	0.3
σ	5
δ	0.0025
γ	2.5
θ	6
ρ_z	0.95
σ_z	0.007
σ_ξ	0.002
σ_g	0.003
σ_v	0.0017
$\frac{G}{Y}$	0.32

[13] Using the alternative value of 11 (implying a markup of 1.1) do not affect the main results in this paper.

μ_1	1.5
μ_2	0.1
μ_3	0.8

The paper will also present results for different values of ϕ_0 and ϕ_1, given the considerable disagreement over the specific formulation of the Phillips curve. Finally, $\frac{G}{Y}$, the government spending-output ratio, equals its period average of 0.32.

5. Model Variants.

Although the model presented above is representative of the NK literature on monetary policy analysis there is considerable disagreement on the specifics[14], especially those regarding the Phillips Curve (Fuhrer, 1997, and Galí and Gertler, 2000) and the importance of technology.

This section will assess the NK model using 3 different variants, with each model being denoted by a different suffix. All the simulated data from the models is contained in the tables in the Appendix and the figures present the dynamic cross-correlations in graphic form. The first model is the one with the calibrated values described in Table II; model 2 only differs from the previous one in that the value of ϕ_1 is equal to 0.1, so that inflation is more sensitive to changes in the output gap (or alternatively, real marginal costs). Model 3 contains the New Keynesian Phillips Curve, that is, inflation is purely forward-

[14] See McCallum (2001) for a lucid discussion of some of the issues.

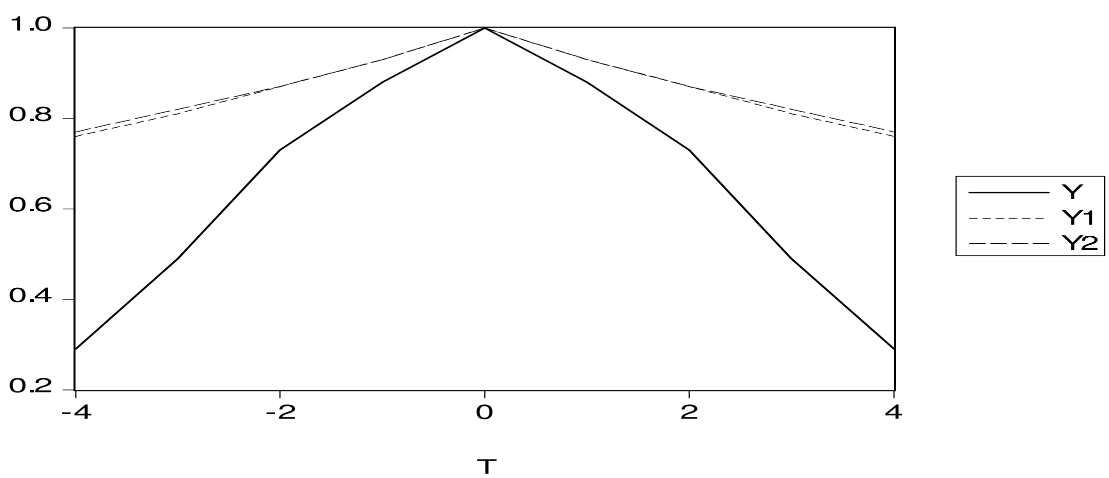
looking and the coefficient on the expected future inflation is equal to β, the discount factor. To contrast with model 3, the fourth model has a value of $\phi_0 = 0.1$ so that inflation is predominantly backward looking. The results for these models are all contained in the appendix, but the cross-correlations can also be seen in graphically, as the figures below show.

5. 1 Output, Consumption and Investment.

Y denotes the autocorrelation coefficients for the data (GDP). Figure I clearly shows that all models exhibit greater persistence than that found in the data and in this respect all models are virtually indistinguishable. The same conclusion is reached for consumption (Figure II) and investment[15].

Figure Ia

Output Autocorrelations.



[15] For lack of space these are not reported here but are available from the author upon request.

Figure Ib

Output Autocorrelations.

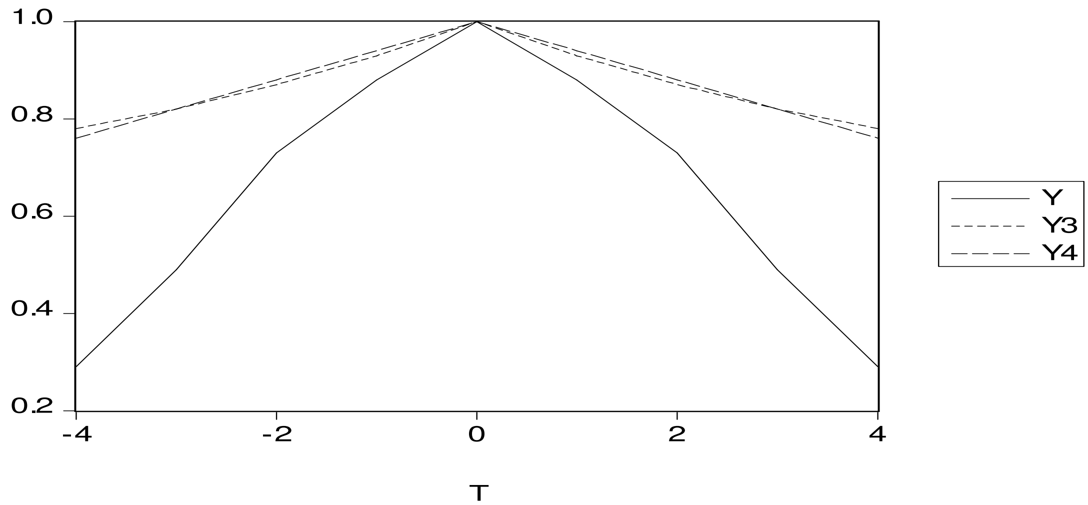


Figure IIa

Output and Consumption

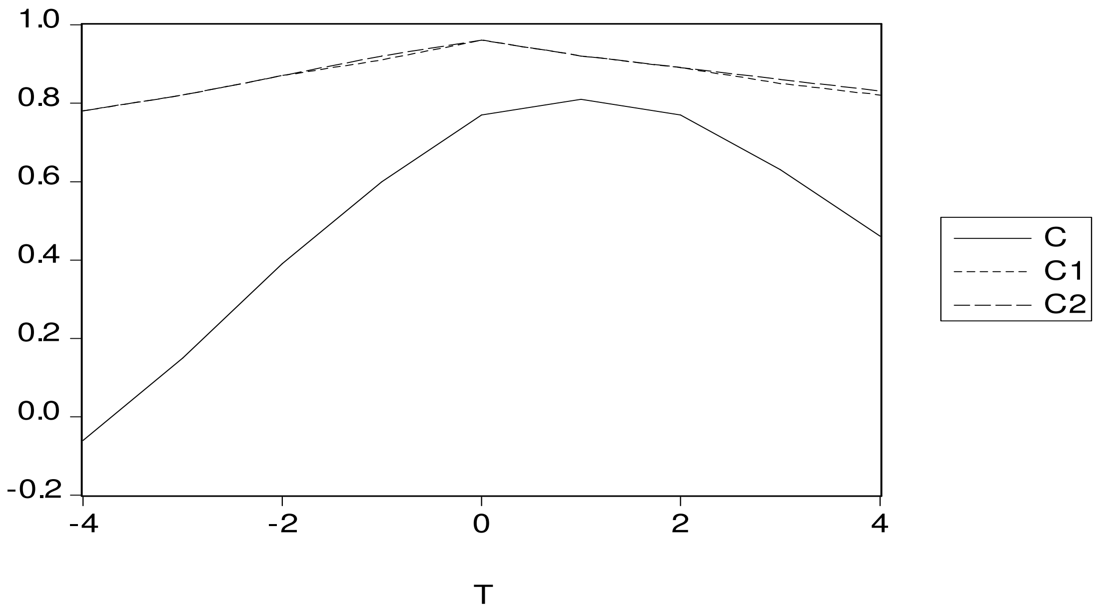
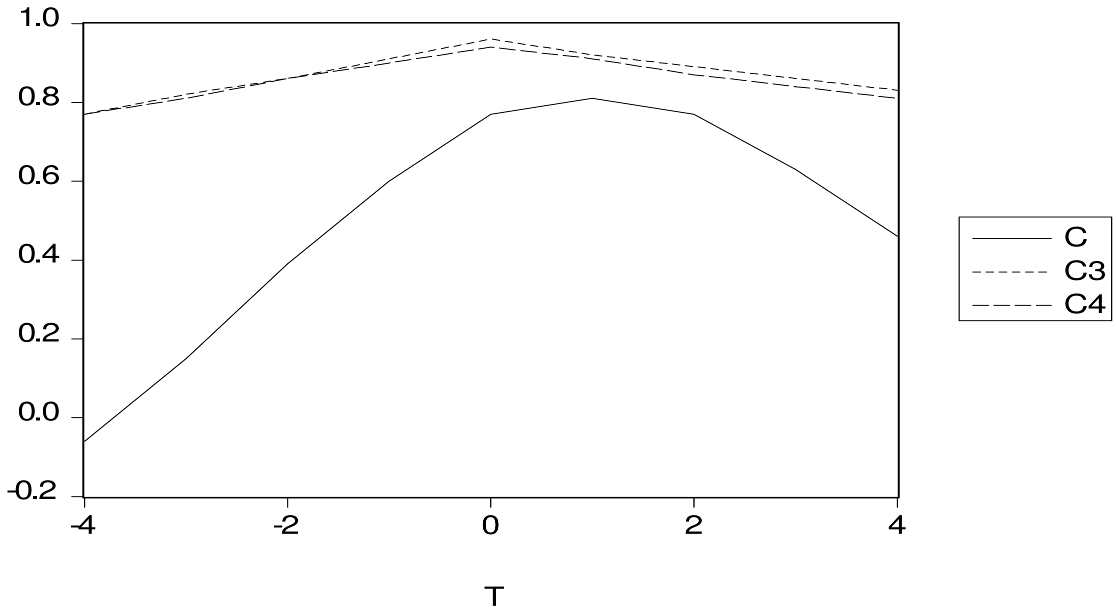


Figure IIb

Output and Consumption



These results are not surprising when one considers that RBCs models possess similar features and that these NK models have the same underlying real structure. In this regard, the main contribution of NK models is their ability to provide an account of the real effects of nominal variables.

5.2 Inflation and Interest Rates.

Figure III presents the results for the cross correlations of output with inflation. It becomes apparent that none of the models described here are able to capture the main dynamics of the data, even qualitatively. The data exhibits a phase shift with the inflation rate lagging the cycle and peaking at around three quarters. Instead, in all the sticky price models described above inflation is strongly countercyclical and leads the cycle. This result is stronger than that reported in Galí and Gertler (1999)[16], since it is not only model 3 (with the New Keynesian Phillips Curve) where inflation leads output, but also in model 4, with backward-looking inflation. These results arise because both technology and the cost-push shocks dominate all other stochastic elements in the model. Moreover, this result is robust to parameter change, posing a serious challenge to sticky price models of the business cycle as described above.

If one extends a similar analysis to the behaviour of the nominal interest rate, the problem is as severe as in the previous case. Again, the data exhibit a phase shift, with interest rates initially being strongly countercyclical and then procyclical. This latter result is not surprising; to the extent that the monetary policy instrument mainly responds to the inflation rate, the models' inability to capture the comovement in inflation is also reflected in its failure to explain the dynamics of the nominal interest rate.

Thus for these two nominal variables, interest rates and inflation, NK models seem unable to explain the comovement between output and nominal variables. This is surprising, given the considerable amount of research and improvements in estimating monetary policy rules and robust estimates of the Phillips Curve. So this begs the question: how should these models be modified?

[16] Also, they treat de-trended output as the output gap, whereas in this paper that variable would be cyclical output and the gap would be the difference between this variable and its flexible price counterpart.

Figure IIIa

Output and Inflation

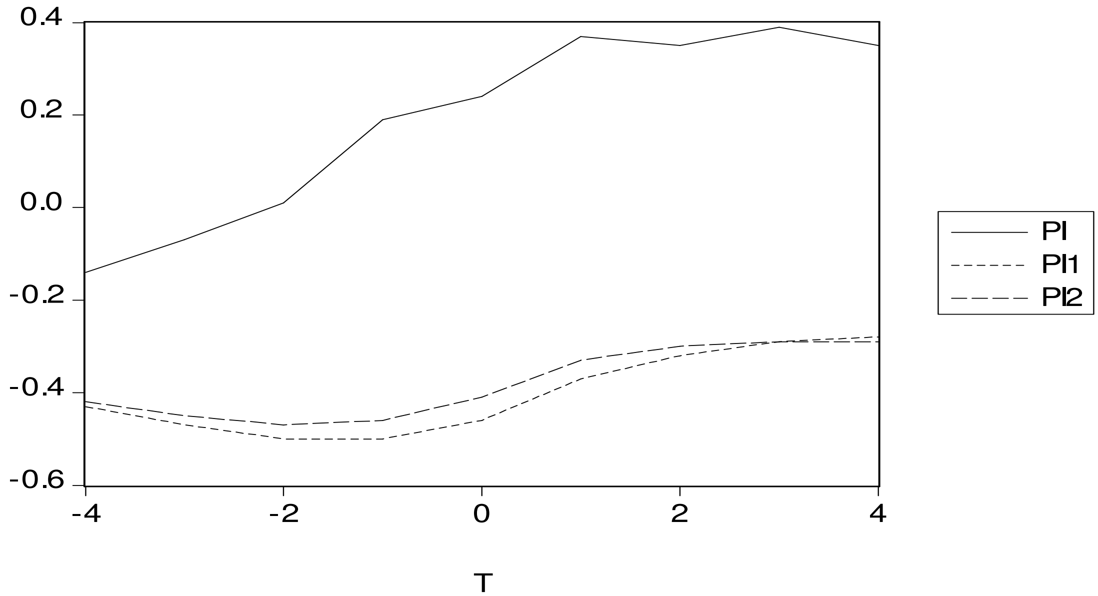


Figure IIIb

Output and Inflation

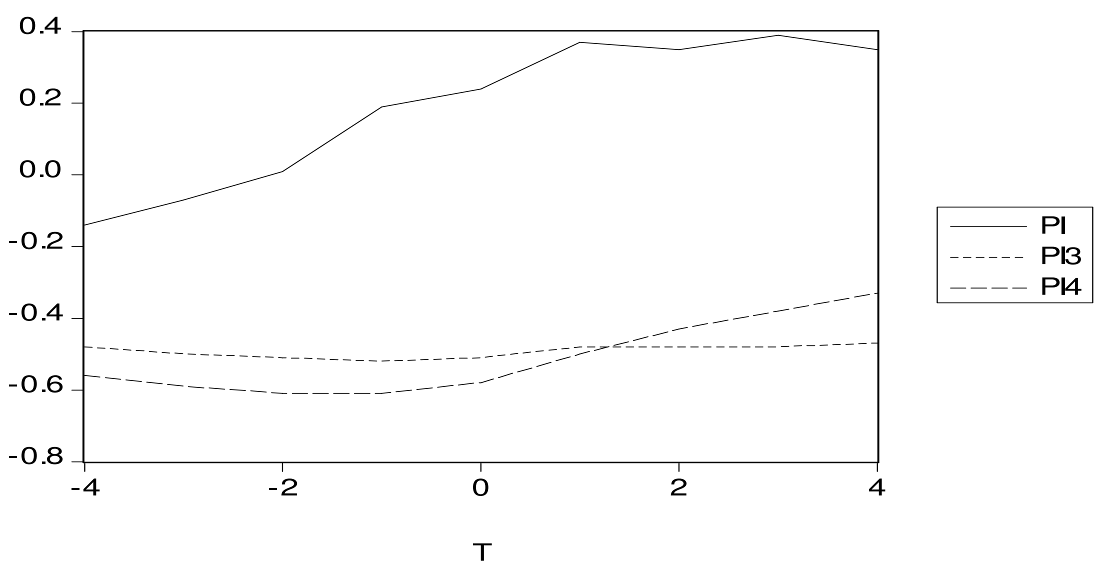


Figure IVa

Output and Nominal Interest Rates

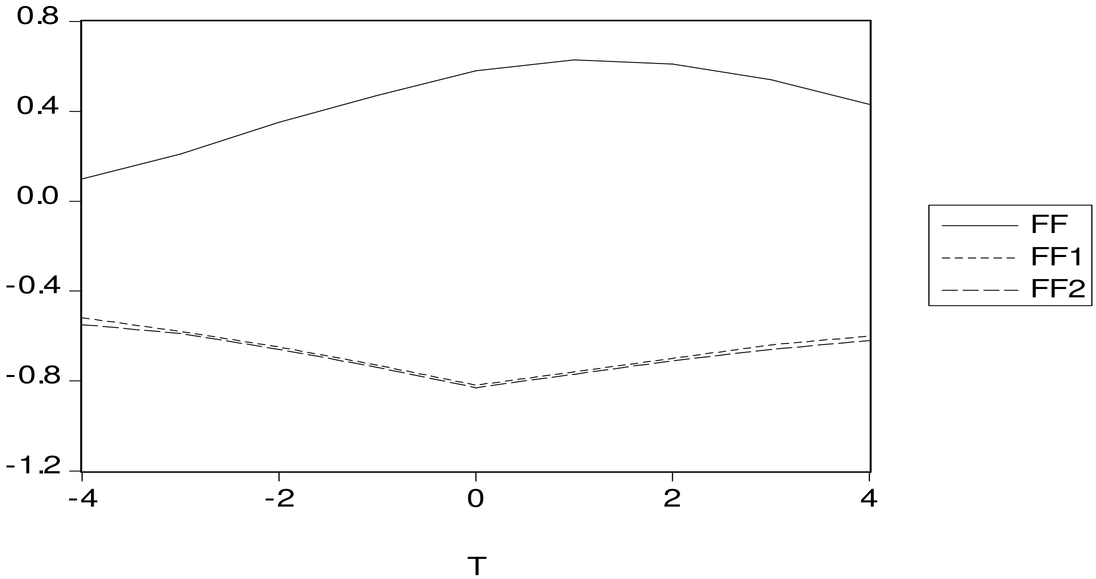
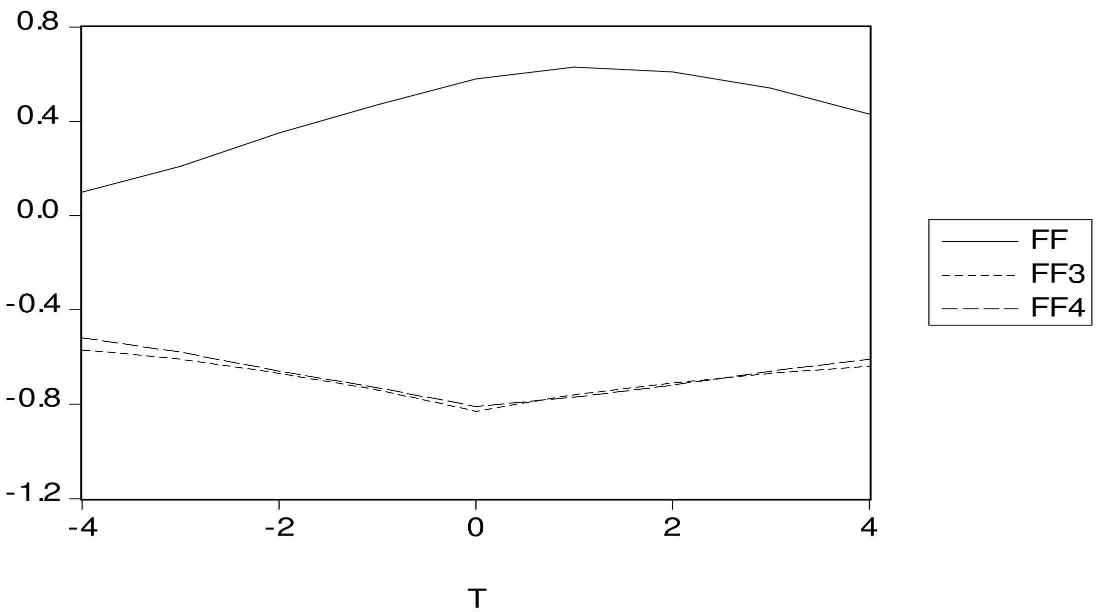


Figure IVb

Output and Nominal Interest Rates



5.3 Operational Monetary Policy.

One issue that the simple models presented above ignored is that monetary policy, as described in equation (7) is not operational. That is, the monetary authorities do not have up to date information on inflation and the output gap[17]. Neglect of operationality in monetary policy is of substantial importance[18], especially when trying to determine optimal monetary policy. However, when the models described in this paper are simulated with the policy rule being operational –that is, using *t-1* information – the results remain robust[19].

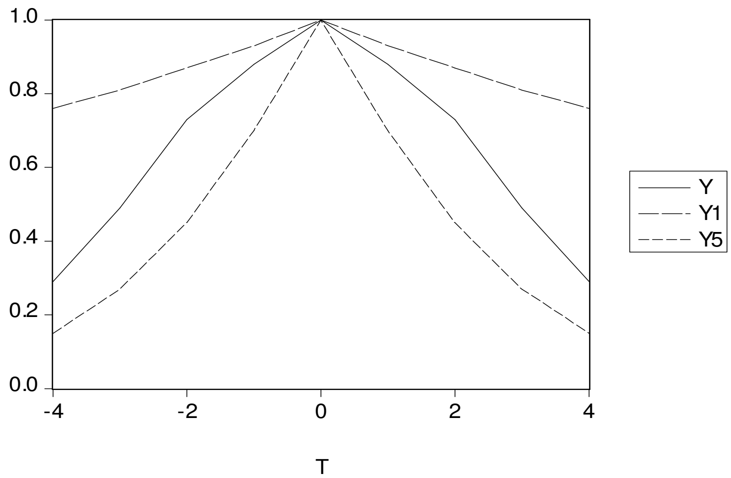
6. The Role of Technology Shocks.

Ever since the Kydland and Prescott (1982) argued that technology shocks were central to understanding fluctuations, many economists (e.g., Summers, 1986) have argued that the role of technology has been overstated. More recently, Galí (1999, 2003) has argued that technology shocks are much smaller than generally estimated. Could this provide an explanation for the puzzles above? Taking the approach to an extreme, one could explore the effects of eliminating technology shocks altogether and this forms our fifth model, shown in Figures.

[17] Issues of uncertainty about the output gap is ignored in this paper.
[18] See, for example, the arguments put forward by McCallum (1997).
[19] These are available in the working paper version to this article.

Figure V

Autocorrelation for Output



This model now possesses less output persistence than the data. As with RBC models, persistent technology shocks provide one of the main persistence mechanisms in sticky price models, and its removal results in the NK model embodying less persistence than in the data. For the purpose of this paper, it is worth noting that inflation now exhibits a phase shift, although it is still countercyclical and leading the cycle[20]. Nevertheless, the countercyclicality of inflation is now less pronounced, and this lends weight to the arguments put forward by Galí (2003), who questions the quantitative significance of technology shocks as a source of output fluctuations[21].

However, the countercyclical behaviour of the nominal interest rate has now become more pronounced compared to all the previous models, because of the effects of the monetary policy shocks.

[20] In this regard, a model that eliminates technology shocks and incorporates backward-looking inflation does not capture these features.

[21] It ought to be mentioned that the standard deviation of technology shocks for the sample period considered here is 0.0055, slightly smaller than the 0.007 traditionally used in RBC models.

Figure VI

Output and Inflation

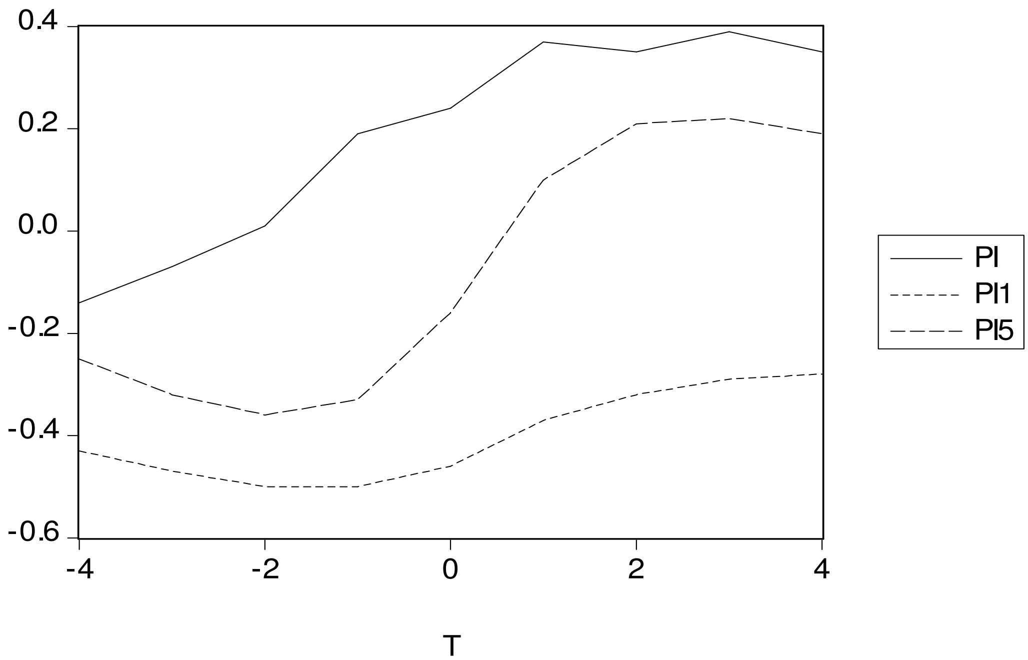
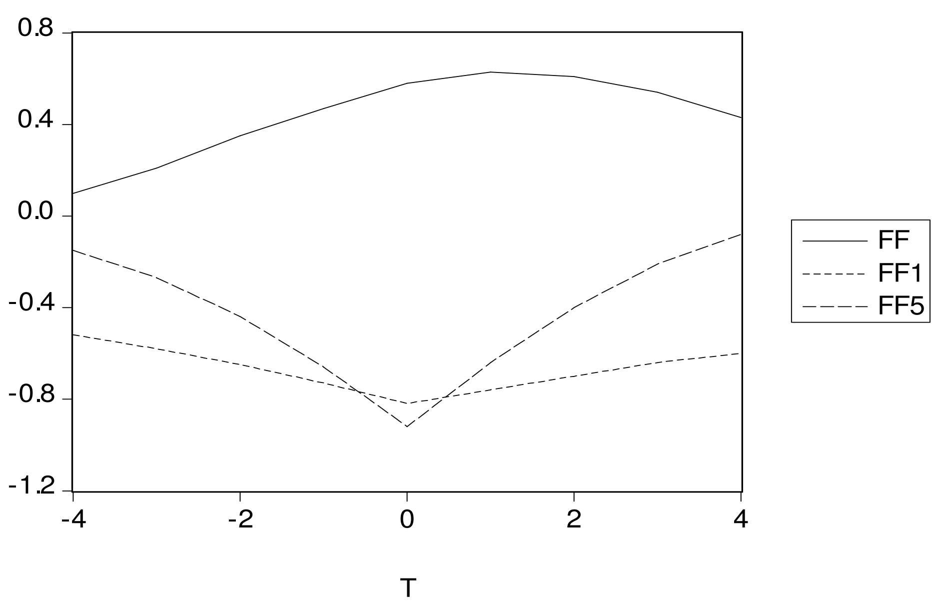


Figure VII

Output and Interest Rates

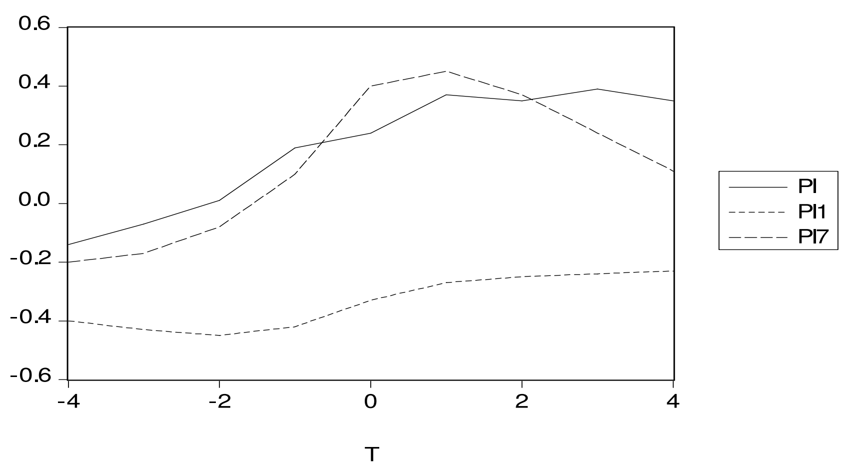


Consequently, one could analyse the benchmark model where demand (monetary and fiscal policy) shocks are the only stochastic elements in the model. The result, not reported here[22], is that inflation lags the cycle and is procyclical, but excessively so. Moroever, the resulting volatility of output is lower than the data's. This suggests re-introducing technology shocks, but with a standard deviation chosen so that the volatility of ouput matches the data's, as is common in RBC modelling and, more recently, in Walsh (2003).

The resulting model[23], shown in Figure VIII , captures the dynamic comovement between output and inflation over the cycle in a manner that none of the earlier models can, even if it does a poorer job at capturing the dynamics of output.

Figure VIII

Inflation-Output Comovement



The relatively large influence of the monetary policy shocks leads to a strong negative correlation between the nominal interest rate and cyclical output, so that although this

[22] Available from the author upon request.
[23] The resulting standard deviation of the technology shock is 0.0019.

model with demand shocks and substantially smaller technology shocks is better able to replicate the cyclical behaviour of inflation, it does a dismal job at describing the behaviour of interest rates[24].

All of the models above have been modified in several ways in order to replicate some characteristics of the US business cycle. In the case of RBCs, part of the dissatisfaction of using the Burns-Mitchell methodology lied in the fact that different models could mimic the data and one could not discriminate in favour of the model that best fit the facts. For the models considered here this problem does not arise. Alternative models result in clearly different cyclical behaviour and modifying the model in order to capture the dynamics of inflation results in one favour specification. The limitation of the NK model is, however, that by being able to replicate the facts for inflation, its performance for the remaining variables, such as output, consumption and the nominal interest rate, has worsened. To the extent that NK models have been designed to explain monetary phenomena the Burns-Mitchell methodology clearly shows some of the limitations of sticky-price business cycle models.

7. Conclusion.

Modern macroeconomics emphasises a model's response to shocks compared to that of a VAR when assessing its performance. Although this approach has yielded many useful insights, it has neglected to consider the implications pertaining to the systematic components of the models.

[24] The additional implication that since there are no cost-push shocks there is no trade-off between inflation and output stabilisation is a further limitation.

This paper has tried to determine to what extent sticky-price models of the business cycle are capable of capturing the sytematic component present in the data, especially with regards to nominal variables. It has done so by using the Burns-Mitchell methodology proposed by Kydland and Prescott (1982) to a variety of sticky-price models, and these are shown to have limited success at replicating the data. This is surprising for two reasons. Firstly, the Burns-Mitchell methodology has partly been neglected when analysing real business cycles because several different models could replicate the data, so one would expect a similar conclusion to be reached for a New Keynesian model. Secondly, New Keynesian models have been designed to explain monetary phenomena, so their inability to describe the behaviour of inflation and interest rates is surprising.

The model that best describes the data embodies a Fuhrer-Moore Phillips curve, monetary and fiscal policy shocks, and small technology shocks. However, although able to replicate the comovement between inflation and output, the results for the nominal interest rate and output are less satisfactory. Following Summers (1986), one should reject models that are unable to replicate the data, but being able to "mimic the facts" does not imply that a model can explain it; that is, it is a necessary but not sufficient criterion. Following this argument, since the sticky-price models considered above cannot replicate the data this poses a serious challenge to the New Keynesian paradigm.

An additional conclusion that emerges from the results in this paper is that by analysing both a model's systematic components and their response to shocks provides further insights and understanding of the model, whereas simply focusing on shocks can result in models that face serious shortcomings.

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TABLE A1

Benchmark model

MODEL I

Variable	ρ_1	t-4	t-3	t-2	t-1	t	t+1	t+2	t+3	t+4
Y	0.93	0.76	.81	.87	.93	1	.93	.87	.81	.76
C	0.97	0.78	.82	.87	.91	.96	.92	.89	.85	.82
X	0.92	0.74	.79	.85	.91	.98	.90	.83	.77	.71
PI	0.69	-.43	-.47	-.50	-.50	-.46	-.37	-.32	-.29	-.28
R	0.87	-.52	-.58	-.65	-.73	-.82	-.76	-.70	-.64	-.60

TABLE AII

Benchmark with $\phi_1 = 0.1$ Model 2.

Variable	ρ1	t-4	t-3	t-2	t-1	t	t+1	t+2	t+3	t+4
Y	0.93	.77	.82	.87	.93	1	.93	.87	.82	.77
C	0.97	.78	.82	.87	.92	.96	.92	.89	.86	.83
X	0.92	.75	.80	.85	.91	.97	.90	.83	.77	.72
PI	0.68	-.42	-.45	-.47	-.46	-.41	-.33	-.30	-.29	-.29
R	0.81	-.55	-.59	-.66	-.74	-.83	-.77	-.71	-.66	-.62

TABLE AIII

MODEL 3 (NKPC)

Variable	ρ1	t-4	t-3	t-2	t-1	t	t+1	t+2	t+3	t+4
Y	0.93	.78	.82	.87	.93	1	.93	.87	.82	.78
C	0.96	.77	.82	.86	.91	.96	.92	.89	.86	.83
X	0.92	.76	.81	.86	.91	.98	.90	.84	.78	.83
PI	0.43	-.48	-.50	-.51	-.52	-.51	-.48	-.48	-.48	-.47
R	0.82	-.57	-.61	-.67	-.74	-.83	-.76	-.71	-.67	-.64

TABLE AIV
Backward looking model. Model 4

Variable	ρ_1	t-4	t-3	t-2	t-1	t	t+1	t+2	t+3	t+4
Y	0.94	.76	.82	.88	.94	1	.94	.88	.82	.76
C	0.97	.77	.81	.86	.90	.94	.91	.87	.84	.81
X	0.93	.74	.80	.86	.92	.98	.91	.84	.77	.71
PI	0.87	-.56	-.59	-.61	-.61	-.58	-.50	-.43	-.38	-.33
R	0.88	-.52	-.58	-.66	-.73	-.81	-.77	-.72	-.66	-.61

TABLE AV
Benchmark without technology shocks, model 5.

Variable	ρ_1	t-4	t-3	t-2	t-1	t	t+1	t+2	t+3	t+4
Y	0.70	.15	.27	.45	.70	1	.70	.45	.27	.15
C	0.84	.18	.29	.44	.62	.81	.64	.49	.38	.30
X	0.72	.16	.28	.46	.67	.91	.63	.39	.21	.09
PI	0.61	-.25	-.32	-.36	-.33	-.16	.10	.21	.22	.19
R	0.71	-.15	-.27	-.44	-.66	-.92	-.64	-.40	-.21	-.08