MONETARY POLICY AND BEHAVIORAL FINANCE

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ABSTRACT

There have been major advances in both theory and econometric techniques in mainstream macro-models and parallel advances in knowledge of the monetary transmission mechanism acting via asset prices. At the same time, behavioral finance has provided evidence that not all actors in the economy are ‘fully rational’ and this has influenced models of asset pricing on which part of the monetary policy transmission mechanism depends. Such uncertainty about the behaviour of asset prices has in part stimulated a move towards ‘robustness’, as an important criterion for guiding monetary policy. We argue that although we have discovered much, including ‘what not to do’, nevertheless our knowledge of the transmission mechanism is very incomplete. This is because, in spite of all the theoretical advances that have been made, there is still considerable uncertainty over the behaviour of agents, which has been reinforced by insights from behavioral finance.

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This paper is an attempt at a brief and therefore necessarily selective account of the links between monetary theory, the asset pricing literature and practical monetary policy. A key part of the story is the ingenuity of academic economists in developing and promoting alternative theoretical models and whether policy makers have been influenced by such models. The paper takes a slightly wider perspective than is usual when discussing monetary policy, by incorporating relevant evidence from behavioral finance, particularly when discussing our understanding of asset prices. We argue that although we have discovered much, including ‘what not to do’, nevertheless our knowledge of the transmission mechanism is very incomplete. This is because, in spite of all the theoretical advances that have been made, there is still considerable uncertainty over the behaviour of agents, which has been reinforced by insights from behavioral finance.

We take as our ‘baseline paradigm’, the competitive general equilibrium model where agents’ decisions on production, consumption, labour supply, asset demands, and wage and price setting are based on maximising behaviour in an intertemporal framework and expectations are (Muth) rational. For example, maximising behaviour for households is usually taken to be intertemporal utility over consumption and for firms intertemporal profit maximisation. We refer to this CGE-RE approach as the ‘standard model’ and we would argue that this is still the dominant paradigm\(^1\). However, even if the latter is not accepted we can still usefully contrast this approach with other models which use non-standard utility functions or incorporate bounded rationality and learning – the aim is to delineate as clearly as possible how far alternative approaches can explain a variety of economic phenomena, which should then influence our view of the usefulness of the standard approach as a basis for practical monetary policy. Whatever model is adopted there is still the \(^2\)question of whether a fully optimal approach or adherence to a (simple) instrument rule\(^2\) is an accurate description and desirable basis for the conduct of monetary policy.

Our central thesis is this. Monetary policy in many developed countries has been subject to fads and fashions over the last 35 years, most notably the New Classical approach and the rise (and fall) of monetarism. However, the standard model is seriously deficient and a much more eclectic approach based on insights from the broad area of behavioral finance should be more widely explored. We would argue that policy makers are ahead of the theorists in one respect – they recognise that the standard approach provides such a weak foundation for monetary policy.
actions (over the policy horizon of 3-5 years), that they eschew both simple instrument rules and fully optimal rules applied to this model - instead they rely on a monetary policy framework based on judgement, transparency and inflation targeting\(^3\). Indeed, we would argue that unless macroeconomists embrace the more eclectic framework of ideas embedded in behavioral finance, macroeconomic models will play little role in policy making and the standing of this branch of economics among policy makers will continue to decline\(^4\). Of course, we see this article as no more than an opening salvo in this debate aimed at ‘nudging’ macroeconomists towards a wider and richer framework of analysis.

We proceed as follows. First, we briefly describe the reasons why ‘money’ no longer has hardly any role in monetary policy. Second, we examine the evidence on the transmission mechanism working via asset prices namely, long rates, stock returns and the exchange rate. Here we also discuss the impact of ‘behavioral finance’ and its broad implications for the monetary transmission mechanism. Finally, we analyse simple instrument rules and fully optimal rules in the context of ‘robustness’, before presenting some brief concluding remarks.

1. WHAT HAPPENED TO MONEY?

In developed economies, in the 1950s and 1960s, Keynesianism largely ruled in monetary policy matters. Fiscal policy could be used to ‘fine-tune’ the economy and the interest rate used to influence the FX-rate, under the Bretton-Woods fixed exchange rate system. In the 1970s, money supply control was strongly advocated as a means to simultaneously control domestic inflation and the exchange rate (which was now floating). The academic debate centred on a stable demand for money function and the use of intermediate monetary targets, often with some form of monetary base control advocated as the policy instrument. It was initially accepted that a contractionary monetary policy might lead to changes in real output in the short run, but with neutrality in the long run. Then came New Classical economics with its emphasis on perfectly flexible prices (hence short run neutrality) and (Muth) rational expectations RE – the latter being ‘model consistent’ expectations. This reinforced the arguments for ‘tough’ monetary targets, as any output losses would be small or non-existent. The Lucas critique emphasised that the parameters of ‘backward-looking’ macroeconomic models might not be invariant to policy changes, if agents were rational. Hence policy simulations of such models used by Central Banks could be misleading. A final ‘theoretical nail’ in the coffin of discretionary monetary policy was provided by Kydland and Prescott (1977) who argued that such policies are likely to be time-
inconsistent, as a policymaker has an incentive to deviate from a disinflationary policy (to obtain short-run gains in output). Even if the latter is not the case in practice, enhancing credibility by committing to a rule can improve the inflation output trade-off, if agents are forward looking.

It is well known that in open economy models with sticky prices and ‘sharp speculators’ the costs of disinflation can be high because of exchange rate overshooting (Dornbusch 1976). The transmission mechanism in open economies is more complex than for closed economy models and there is much debate on the best way to model the exchange rate – a key part of the monetary transmission mechanism.

Given the zeal with which monetary supply control and monetary targets were advocated by numerous economists, it is rather ironic that there are now a number of Central Bank macroeconomic models in which the stock of money has no causal role and some of these models may not include a monetary aggregate at all (e.g. models at the Bank of England, The European Central Bank, the Federal Reserve System and Bank of Canada, - see Laidler 1999, King 2002, Meyer 2001)\textsuperscript{5}.

In a world where banks did not compete for wholesale deposits or were subject to interest rate ceilings, the demand for narrow money (M1) appeared to be reasonably stable (e.g. Artis and Lewis 1984, Patterson 1987, Boughton 1993, Hendry and Ericsson 1991). But in the UK in the 1970’s and 1980’s banks were able to bid for wholesale deposits (e.g. CD’s) so the demand for broad money (M2, M3, M4) depended on the ‘own rate’ as well as the rate on substitutes (e.g. bonds, T-bills) and the demand for broad money became unstable. In the 1980s the rational expectations revolution influenced the analysis of the demand for money, which now included forward looking variables and the idea that money could act as a buffer stock absorbing shocks to output and prices (Laidler 1984, Cuthbertson 1988 Cuthbertson and Taylor 1987). But as conditional forecasts depend on current (and past) information, a forward looking model can be re-parameterised to give a purely backward looking (error correction) money demand equation – however, and use of forward looking variables failed to adequately address the instability in money demand\textsuperscript{6}.

**BANK LENDING**

If bank lending can change independently of changes in interest rates by the monetary authorities then this leads to changes in the money supply (i.e. the liabilities side of the banks’ balance sheet). This rather naturally gives rise to the idea of money acting as a ‘buffer stock’, where it is willingly held in the short run. It may then be the case that output, prices and relative interest
rates adjust, as bank loans lead to additional real expenditures (and expenditure on financial assets) which validate the additional money holdings in the long run. However, because of the multiplicity of credit channels and securitisation of bank (and other financial institutions') assets, this process is difficult to model.

There have been several attempts to try and rescue the stability of money demand in the 1980s and 1990s. For example, systems demand functions (Barr and Cuthbertson 1991, Cuthbertson 1997), Divisia aggregates which weight each type of bank deposits by their ‘moneyness’, so that each dollar of currency and demand deposits have a higher weight than savings (term) deposits (Barnett et al 1984, Janssen 1996) and buffer stock approaches (e.g. Mizen 1997). In our view these have not proved successful, particularly in the face of financial innovation (Baba et al 1992, Hess et al 1994, Hendry and Starr 1993) - although this will be disputed by some (see for example, Chrystal and Mizen 2005). Using the money stock as an intermediate target or even as a useful ‘information variable’ has therefore largely disappeared in policy debates and in Central Bank thinking. In the UK this was summed up in Goodhart’s Law (after Professor Charles Goodhart of the LSE and ex-Chief Economist at the Bank of England). His view was that as soon as you try and control some monetary aggregate, it ceases to measure what it used to measure. John Biffen, a UK Treasury minister in the Thatcher government in the 1980’s, put it a little more prosaically when (paraphrasing Oscar Wilde on foxhunting) he described monetary targeting as “the immeasurable in pursuit of the uncontrollable”.

BEHAVIOUR OF BANKS

Another reason why ‘money’ has become less important is the difficulty in finding policy instruments which allow reasonable control over the money supply – particularly in a financial system subject to rapid financial innovation. Money is one ‘output’ of the banking system but this now involves not only bank lending, but securitisation, collateralised debt obligations, structured finance and derivatives trading. This is a long way from the ‘money multiplier’ analysis of the economics text-books. For example, banks face new capital charges for credit risk under Basle II, which will be compulsory for most financial institutions in developed economies. If a bank’s capital cannot support its level of (risk adjusted) bank lending, this may result in a ‘credit crunch’ since there is no interbank market in ‘capital’ (as there is in bank reserves). Also, one cannot rule out the possibility of monetary shocks from the supply side which impinge on the value of collateral held by firms, resulting in debt deflation. Japan seems the key contemporary example here, as very low interest rates failed to stimulate the economy over a long period. These effects are difficult to pin down precisely in empirical work and are part of the reason for the ‘long and
variable lags’ of monetary policy. Because such effects are complex and require a model of the banking system, they rarely feature in ‘theoretical’ models (like Cash-in-Advance, Real Business Cycle and the New Keynesian model outlined below). However they are often the talking point in Central Bank monetary policy meetings.

NEW KEYNESIAN MODEL

Given substantial instability in money demand (i.e. the LM-curve) then the simple Poole (1970) analysis implies that to minimise oscillations around an output (and hence inflation) target one should use the interest rate as a policy instrument rather than the money supply. (This applies a fortiori if the determination of the money supply is also highly uncertain). In part, this is the starting point for the ‘new consensus’ (or New Keynesian) closed economy model of monetary policy, which uses the interest rate as the policy instrument. In its simplest version the model consists of an IS-curve and a Phillips curve trade-off between inflation and the output-gap.

\[ y_t = -\Phi \left( r_t - E_t \pi_{t+1} \right) + E_t \pi_{t+1} + \theta x_{t-1} + g_t \]

\[ \pi_t = \lambda x_t + \beta E_t \pi_{t+1} + \Psi \pi_{t-1} + u_t \]

where \( x_t \) = output gap, \( r_t \) = interest rate, \( \pi_t = \pi^* \) = deviation of the inflation rate from its target rate and \( g_t \) and \( u_t \) are ‘shocks’ (possibly serially correlated). The objective function for the monetary authorities varies somewhat but is typically an intertemporal loss function:

\[ E_t \sum_{i=0}^{\infty} \beta^i \left( \alpha x_{t+i}^2 + (\pi_{t+i} - \pi^*)^2 \right) \]

where \( \alpha \) is the relative weight on output fluctuations. In addition, restrictions are often placed on the volatility of the short-term interest rate.

There is a burgeoning literature on the microfoundations of the structural equations [1] and [2] and the choice of loss function [3], that we omit in our discussion (see for example, Woodford 2003, Clarida, Gali and Gertler 1999, 2001). In the New Keynesian model, the money stock is wholly endogenous and in fact, irrelevant. The money stock responds to the demand for money, which in turn is determined by the optimal policy choice for \( r_t \) (and the resulting \( x_t \) and \( \pi_t \)).
The ‘new consensus’ model has forward and backward looking elements. The nominal short-term interest rate is the policy instrument while the real interest rate influences the output gap which in turn influences inflation. It is probably fair to say that this New Keynesian model may be ‘new’ as far as many academic US economists are concerned (given their previous advocacy of New Classical and real business cycle RBC models), with monetary policy giving rise to changes in real variables in the short run (see Bean 1998). Most European economists might justifiably proclaim *déjà vu*, as it is the type of model many have advocated, during the time various theoretical macroeconomic ‘revolutions’ have emanated from the US.

It is also true that European economists have long been adept at solving such models with backward and forward looking elements, even when the models are large and complex (see for example Fisher et al 1986, Hall and Henry 1986) and optimal control solutions for policy instruments under discretion and commitment have been available for some time (e.g. Hall 1986).

Because the New Keynesian model has forward looking behaviour then today’s output depends on future real interest rates (iterate equation [1] forward with \( \theta = 0 \) for simplicity).

\[
[4] \quad x_t = -E_t \sum_{i=0}^{\infty} \left\{ -\Phi(r_{t+i} - \pi_{t+i+1}) + g_{t+i} \right\}
\]

Hence, in such models the *credibility* of policy is of paramount importance. One practical way of introducing credibility without specific adherence to a fully optimal or simple instrument rule is to appoint a conservative Central Banker who has a greater aversion to inflation (i.e. smaller \( \alpha \)) than society as a whole (Rogoff 1985) – this appears to be the case in the US under Greenspan and in the UK after the Bank of England became independent in 1997. The inflationary bias under discretion noted by Kydland and Prescott (1979) and Barro and Gordon (1983) does not seem to have been a major cause of concern in the US (Blinder 1997) and the major OECD countries (Friedman and Kuttner 1996) after around 1980, since the latter countries reduced inflation without independent conservative central bankers. It is encouraging that the New Keynesian model now appears to be widely accepted in the US (Clarida et al 1999 and references therein), which except for open economy aspects brings the US closer to the existing academic consensus on monetary policy in Europe. The emphasis also appears to be shifting from fully optimal solutions for \( r_t \) (usually for ‘small’ models) towards simple instrument rules (e.g.
Taylor type rules), or a (simple) rule which is robust across alternative ‘candidate’ models. Taylor rules have $r_t$ responding slowly to the output gap and deviation of inflation from target:

\[ r_t = \theta_r r_{t-1} + (1 - \theta_r) \gamma \pi E_t (\pi_{t+1} - \pi^*) + \gamma x_t \]

This is discussed further below, but note that even in a closed economy the optimal degree of inertia (i.e. value of $\theta_r$) of the policy instrument $r_t$, depends crucially on the structure of the model, in particular the strength of lagged adjustment or inertia in real variables relative, to the importance of forward looking RE variables. Hence, the debate has in a sense turned full circle. No longer is the debate over monetary policy focused on either ‘money supply’ versus ‘interest rate’ control or on short-run neutrality, but is about earlier disagreements on the relative importance of expectations versus sluggish adjustment in macroeconomic variables.

Before we examine this debate, we need to look at some possible alternative transmission mechanisms from the short rate to real expenditure, via asset markets. This will also throw some light on the validity of using the standard model as a basis for macroeconomic analysis.

2. ASSET MARKETS AND THE TRANSMISSION MECHANISM

Prices in asset markets with rational agents should be determined by forward-looking behaviour. There is plentiful data as well as a large number of informed active traders, both of which should facilitate testing of equilibrium rational expectations (RE) models. The main asset markets, namely bonds, stocks and foreign exchange also constitute part of the transmission mechanisms of monetary policy. For example, the expectations hypothesis of the term structure links short term interest rates as set by the monetary authority with longer term rates, that are thought to influence expenditure on consumer durables, housing and other fixed investment. Interest rates also influence returns and future expected returns on stocks, which via the rational valuation formula lead to changes in stock prices. If the persistence in stock returns is high then changes in interest rates can have a powerful influence on stock prices (Campbell 1991). To the extent that lower interest rates lead to upward revisions to dividend growth, this can also affect stock prices. The monetary channel via stock prices works via changing financial wealth (and hence consumption) or by changing Tobin’s Q and fixed investment (Cuthbertson and Gasparro 1993, Erickson and Whited 2000). Interest rates may also influence house prices and consumption, via changes in wealth. Finally, under floating exchange rates, changes in short term
rates are thought to influence the exchange rate via uncovered interest parity which might result in overshooting (Dornbusch 1976). A key question for monetary policy is whether the standard model can adequately explain the behaviour of asset prices and hence links to variables such as output and inflation⁹.

The 'standard model' used for asset returns is the stochastic discount factor approach SDF – and this also provides the microfoundations for the IS curve in the New Keynesian model (see Clarida et al 1999). Agents maximise (time separable) expected lifetime utility from consumption, which gives rise to a first order condition:

\[ E_t (R_{t+1} M_{t+1}) = 1 \]

where \( R_{t+1} \) is the return on any asset-\( i \) (including the risk free asset) and \( M_{t+1} \) is the SDF. With power utility over consumption, \( U(C_t) = C_t^{1-\gamma} / (1-\gamma) \) the model becomes the C-CAPM:

\[ M_{t+1} = \theta U'(C_{t+1})/U'(C_t) = \theta (C_{t+1}/C_t)^\gamma \]

where \( C_t \) = consumption, the discount rate \( \theta = 1/(1+t_p) \), and \( t_p \) is the subjective time preference rate (for annual data \( \theta \approx 0.97 \)). Equation [6] does not rule out the possibility that returns are predictable. Under joint lognormality of consumption growth and asset returns the model gives:

\[ r^*_t = k + \gamma E_t \Delta c_{t+1} - (\gamma^2 / 2)\sigma^2_t(\Delta c_{t+1}) \]

\[ E_t(r^*_{t+1} - r^*_t) + (1/2)\sigma^2_t(r^2_{t+1}) = -\text{cov}_t(m_{t+1}, r^*_{t+1}) \]

where \( r^*_t = \ln(1+R^*_t) \), \( r^*_p = \ln(1+R^*_p) \) and \( c_t = \ln C_t \). Tests of the Euler equation [6] using [7], on a set of risky asset returns implies cross-equation restrictions, since \( \gamma \) the coefficient of relative risk aversion (crra) appears in the equation for each return. Such tests on a wide variety of risky assets (including foreign assets) usually clearly reject the model and give implausibly large (or even negative) values for \( \gamma \) (e.g. Grossman & Shiller 1981, Cochrane 2001).
An alternative assessment of the C-CAPM is provided by equations [8] and [9]. Ignoring the second term in [9], the average excess return on stocks (i.e. the equity premium) depends on $\gamma \text{cov}_t(\Delta c_{t+1}, r^s_{t+1})$. Empirically, the covariance between consumption growth and stock returns is relatively low so we require a high value for $\gamma$ (e.g. greater than 20) if the model is to predict the observed equity premium of around 6-8% p.a. This is the equity premium puzzle (Mehra and Prescott 1985). Also the average growth in consumption is around 1-3% p.a. which if $\gamma = 20$, then equation [8] predicts a high average level of the risk free rate and one which is highly variable (as $E_t(\Delta c_{t+1})$ varies). But in the data, the average (real) risk free rate is rather low and not very variable: this is the risk free rate puzzle (Weil 1989, Kocherlakota 1996).

A possible resolution of the equity premium puzzle is to allow utility to depend on additional variables $Z$, in a non-time separable fashion$^{10}$. Then marginal utility is of the form $U'(c, Z)$ and the expected return on equity depends on the covariance between the asset return and $Z$ as well as between the asset return and consumption and if the former is large, then the high equity premium may be explained with a low risk aversion parameter. This is the route taken in some of the behavioral finance literature (see below)$^{11}$.

There is a key underlying problem in using the standard expected utility framework for ‘microfoundations’ of macroeconomic behavior. As long as utility is solely an increasing concave function of wealth (consumption), then expected utility although reasonable for small bets, implies absurd results for large bets. To see this consider the following proposal. Suppose we know that M/s Casino, who is a risk averse expected utility maximiser$^{12}$, will always turn down a 50-50 gamble of losing $10 or gaining $11, for all initial wealth levels. Now we offer M/s Casino a 50-50 bet where she could lose $100 and gain $Y$. What is the biggest $Y$ we can offer so that we know she will turn down this bet? Casual introspection would suggest M/s Casino might turn down the bet for a mere $Y=$110 gain or maybe even for $Y=$2,000 gain but surely she would not turn down the bet for the chance of winning $Y=$20,000 and certainly not for $Y=1m$ or $Y=1bn$ to win (remember she can only lose $100). In fact, as an expected utility maximiser, if she always rejects the 50-50, lose $10/gain $11, then she will always refuse a 50-50, lose $100/gain any amount. This is the Rabin paradox (Rabin 2000) and the result seems absurd and makes one very uneasy about using expected utility based only on the level of wealth (consumption), as a criterion when considering large bets – or equivalently large shocks to consumption$^{13}$. The proviso “for all initial wealth levels” influences the extreme result above but does not rescue expected utility.

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For example, if an expected utility maximiser turns down a 50-50 lose $100/gain $105 for any wealth level less than $350,000 then that person from an initial wealth level of $340,000 will also turn down a 50-50 bet of losing $10,000 and gaining $5.5m.

The latter conclusion cannot be overturned by considering repeated bets of the same type. If a person turns down one fair bet to lose X or gain Y, then expected utility implies the person will turn down an offer to play many of these same gambles (Samuelson 1963). The above conceptual difficulties with expected utility maximisation as a basis for ‘microfoundations’ in financial markets, has led to alternatives where utility depends on changes in wealth, where losses are much more ‘painful’ than gains (e.g. loss-aversion or disappointment aversion) and where individual’s consider gains and losses in isolation (i.e. ‘narrow framing’). We discuss these below.

Another way of looking at the failure of the standard approach to explain behaviour in the stock market, is to examine the rational valuation formula RVF for stock prices:

\[ P_t = V_t = E_t \sum_{j=0}^{\infty} \delta_{t+j} D_{t+j} \]

Where \( P_t \) = stock price, \( V_t \) = fundamental value, \( \delta_{t+j} = \delta_t \delta_{t+1} \ldots \delta_{t+j} \) is the time varying discount factor and \( D_t \) = dividends. Testing the model proceeds in two main ways. Volatility tests (Shiller 1989) proceed by replacing the forecasts of \( \delta_{t+j} \) and \( D_{t+j} \) by their actual values to give the ‘perfect foresight price’ \( V_t \) and it can be shown that under rational expectations:

\[ \text{Var} (P_t) \leq \text{Var} (V_t) \]

The data tends to reject this inequality (after taking account of non-stationarity problems). An alternative set of tests uses a linear approximation of [10]:

\[ \delta_t = E_t \sum_{j=1}^{\infty} \rho^{j-1} (h_{t+j} - \Delta d_{t+j}) \]

where \( \delta_t = d_t - p_t \) is the log-dividend price ratio, \( h_{t+j} \) is the one-period return on the stock and \( \Delta d_{t+j} \) = growth rate in dividends. Forecasts of the right hand side variables in [12] can be
obtained using a vector autoregression (VAR) and this forecast is referred to as the ‘theoretical’ dividend-price ratio $\delta^*_t$. If the RVF + RE is correct then (forecast) movements in $\delta^*_t$ should match movements in the actual dividend-price ratio, $\delta_t$.

[Figure 1 here]

We have applied the Campbell-Shiller (1989) VAR methodology to a long time series of UK data. Results, assuming the (real) excess return on stocks is constant (i.e. $h_{t+1} - r_t =$ constant) are shown in figure 1 for UK annual data 1920-2001. Clearly the actual dividend-price ratio $\delta_t$ is much more volatile than the (forecast) ‘theoretical’ dividend-price ratio $\delta^*_t$: this is excess volatility again. Similar results are obtained for other major stock markets (see Campbell-Shiller1989, Campbell 1991, Cuthbertson et al 1997, Cuthbertson et al 2002) and this excess volatility points to the possible influence of non-rational traders in stock markets (Campbell and Shiller 1989). To the extent that any noise traders are likely to invest worldwide, the presence of noise traders may have implications for movements in the exchange rate, particularly with increasing international portfolio diversification (Shiller 2001).

The debate over the predictability of aggregate stock market returns is more finely balanced and perhaps there is a tendency to accept the null of there being no predictability, that can be exploited to make abnormal returns. The problem here is that a slight divergence from the null may still imply that prices can exhibit substantial divergence from fundamental value over long time periods$^{14}$.

Alternatives to the presence of noise traders as an explanation for the failure of the EMH are the failure of RE (which is equally problematic to forward looking RE macro-models) or a time varying risk premium. There is some evidence that persistence in volatility can have a large effect on future expected returns (discount rates) and hence stock prices (for the UK see Cuthbertson et al 1997 and for the US, Black et al 2003) - empirically, this hypothesis goes some way to restoring the RVF. However, the balance of the evidence in our view is that the standard model is deficient in accounting for the behaviour of stock prices$^{15}$.
BOND MARKET AND THE EXPECTATIONS HYPOTHESIS

In the (default free) bond market the stochastic discount factor SDF approach (under lognormality) gives rise to:

\[ S_{t}^{(n,1)} = E_i \sum_{i=1}^{n-1} \left( 1 - i / n \right) E_i \Delta r_{t+i} + \text{risk premium} \]

where \( S_{t}^{(n,1)} = R_{i}^{(n)} - r_{t} \), \( R_{i}^{(n)} \) = spot yield on an n-period bond, \( r_{t} \) = risk free rate. The risk premium in the SDF model involves conditional covariances between the (logarithm of the) SDF, \( m_{r+i} \) and the yield on bonds (up to maturity n-1). However, most empirical work has invoked the assumption of risk neutrality (and a negligible Jensen effect) so the 'risk premium' is time invariant in [17], giving rise to the expectations hypothesis, EH.

The importance of the EH of the term structure for the monetary policy transmission mechanism is clear. Under a Taylor rule where changes in the short rate are persistent, a small rise in current interest rates (to combat inflationary pressures) will under RE lead to an expectation of further rises. Via the EH this will lead to a substantial rise in long rates, which gives the monetary authority leverage over real expenditure. The monetary authorities appear to avoid large changes in short-term interest rates. A fear of disorderly markets may prevent Central Banks from undertaking an aggressive stance on changes in short-term rates or such inertia may simply reflect a prompt interest rate adjustment in response to persistent shocks or new information (Rudebusch 2002, 2005, Cobham 2003). Indeed, frequent interest rate changes might induce substantial ‘risk’ into the bond market. This would then interfere with the above transmission mechanism via the EH, since the risk premium would then be time-varying, and would add an extra element of uncertainty about movements in the long rate (e.g. see Tzavalis and Wickens 1995 who investigate the breakdown of the EH in the US in the 1979-82 period).

How well does the EH stand up to empirical scrutiny? For the UK, using the Campbell-Shiller (1991) VAR methodology, the forecast of future change in short rates is given by the right hand side of [13] and is known as the ‘theoretical spread \( S'_{t} \). At a minimum the VAR contains an equation for the spread \( S'_{t}^{(n,1)} \) and the change in the short rate \( \Delta r_{t} \) (but other variables can also be included if they are thought to add explanatory power to forecasts of the short rate). If we define \( z_{t} \equiv ( S_{t}, \Delta r_{t} )' \) then the estimated VAR can be written \( z_{t+1} = A z_{t} + v_{t+1} \), where (for a first order VAR) \( A \) is a (2x2) matrix. Now define \( e_{2}' = (0,1) \) and the forecast values of \( \Delta r_{t+1} \) are
given by \( E_t \Delta r_t = e^{2t}A^t z_t \) and can be substituted in the right hand side of [13] to give a forecast of the 'theoretical spread. For example for \( n=3 \), \( S_3' = e^{2t}(\frac{2}{3}A + \frac{1}{3}A^2)z_t \).

Testing the EH then involves a comparison of the time series of \( S_t' \) and the actual spread \( S_t \) (see [18]) and these should be equal (for all \( t \)) if the EH is correct (see Cuthbertson and Nitzsche 2004). For the two year-one month spread, \( S_t' \) is shown by the dashed line in figure 2 and the actual spread \( S_t \) is the solid line. More formal tests than 'eyeballing' the time series in figure 2 indicate that the EH is largely accepted (i.e. not rejected) by UK data. This conclusion seems to apply across several countries, except in very turbulent periods (e.g. Tzavalis and Wickens 1995, 1997, Longstaff (2000), Bekaert et al 1997, 2001, Cuthbertson 1996, Cuthbertson and Nitzsche 2003, Engsted and Tanggaard 1995, Sarno et al 2005).^{16}

[Figure 2]

Why does the EH seem to fit the data reasonably well while the RVF for stocks does not? There can be no definitive answers here but only informed guesswork. First, the bond market has an 'anchor', namely the maturity value of the bond, so rational (or irrational) bubbles are ruled out. Second, the forecast of future short rates depends on forecasts of the real interest rate (which changes only slowly) and forecasts of inflation – and the latter is subject to smaller forecast errors than forecasts of future dividends and discount rates. So, the perceived riskiness of (government) bonds is probably less than for stocks and hence any time varying bond risk premia may be less important than news about future short rates (for evidence on the latter, see Tzavalis and Wickens 1997 for the US and and Cuthbertson and Nitzsche 2003 for the UK).

The importance of work in empirical finance in testing alternative paradigms is that it gives a broader perspective on what is required to explain behavior in markets that one would think are most likely to follow the 'standard model' since information is plentiful, transactions cost are low and by-and-large, data is measured with less error than for macroeconomic aggregates.

**MONEY AND EXCHANGE RATES**

The seminal model of the transmission mechanism from monetary policy to the exchange rate under \( RE \) is the Dornbush (1976) overshooting model (and extensions, e.g. Frankel 1980). The model does not necessarily require a stable money demand function since the key features are uncovered interest parity UIP and sticky goods prices, but with purchasing power parity PPP.
holding in the long run. Of course if the money supply is to be the policy instrument then a stable money demand function is required. But if the interest rate is the policy instrument we can dispose of money demand, as long as we have a plausible transmission mechanism from interest rates to inflation and the exchange rate.

Note that even if you were an avowed ‘monetary model of the exchange rate’ proponent, it is not sufficient to posit the long run-neutrality of money (i.e. money proportional to prices) and PPP. There may be cointegration between these I(1) variables but that does not prove causality. Money could be purely endogenous in this ‘model’. Incorporating these elements into a vector error correction model (VECM) allows one to examine Granger causality and here the causal link from money to prices (and vice versa) is far from clear cut or stable (see Hallman et al.1991, Hall and Milne 1994).

For open economy monetary models using a VECM framework Rapach and Wohar (2002) provide a comprehensive study using over a century of annual data for 14 exchange rates (against the USD). Results using a battery of tests are mixed, with cointegration between money and the exchange rate holding for France, Italy, Netherlands and Spain and moderate support for Belgium, Finland, Portugal and Switzerland and no support for Australia, Canada, Denmark, Sweden and the UK. Where cointegration has been established, Rapach and Wohar then run a bivariate VECM:

\[
\begin{align*}
\Delta s_t &= \beta_{11}[\Delta s_{t-j}, \Delta fdm_{t-j}] + \alpha_{11}z_{t-1} + \epsilon_{1t} \\
\Delta fdm_t &= \beta_{21}[\Delta s_{t-j}, \Delta fdm_{t-j}] + \alpha_{21}z_{t-1} + \epsilon_{2t}
\end{align*}
\]

where ‘fundamentals’ \(fdm_t = (m - m^*), -(y - y^*)\), \(s_t = \) spot FX rate and \(z_t = (s - fdm)_t\) is the error correction term. They use [15] to provide ‘outside sample’ forecasts for \(\Delta s_t\), updating the parameters each year, using data up to t-1 and forecasting one-year ahead. The forecasts using fundamentals are compared to the ‘no-change’ random walk prediction, using a variety of standard metrics (e.g. mean square error, MSE). They find that the monetary model outperforms the random walk forecasts for some of the countries (Belgium, Italy and possibly Switzerland) but not others (e.g. France, Portugal, Spain). Also note that Rapach and Wohar’s (2002) forecasting results allow the coefficients on the dynamics to alter every period (i.e. they may not be constant)
and we do not know the contribution of the short-run ‘delta’ terms relative to that of the ECM term, to the overall forecast performance. It is not saying a lot if \( \Delta s_t = f(\Delta s_{t-1}, \Delta fdm_{t-1}) \) provides a better forecast than simply \( \Delta s_t = k \). It is the ECM term which embodies the long run economic theory so it would be interesting to know whether excluding this term leads to a major deterioration in the forecast performance\(^{18}\).

When using a long time series of data, where the estimation is undertaken over several different regimes (e.g. fixed, floating exchange rates and currency bands), this may lead to biased estimates of the coefficients. But this argument should not unduly bias the cointegration results (which are long-run in nature) but may influence the dynamics – although Rapach and Wohar (2002) allow the coefficients on the short-run dynamics to change each year. Overall, even this technically proficient ‘re-run’ of the monetary model gives far from satisfactory results and one cannot imagine a central banker using this type of model when deciding on the monetary policy stance, for ‘moderate inflation’ countries considered in the study.

Forward looking (RE) models of the exchange rate are based on PPP, a stable money demand function and the UIP condition. The spot rate equation is of the form:

\[
[16] \quad s_t = (1+\lambda)^{-1} \sum_{i=0}^{\infty} \left[ \frac{\lambda}{(1+\lambda)} \right] E(x_{t+i} / \Omega_t)
\]

where \( x_t = (m-m^*) - \phi(y-y^*) \), are the domestic/foreign monetary fundamentals. Clearly from [16] the spot rate depends on the future course of monetary policy and a credible monetary policy can have a powerful effect on the spot rate. Assuming a VAR forecasting equation for \((s_t, x_t)\) gives the usual RE cross-equation restrictions on the parameters of the VAR and a time series forecast for the right hand side of [16], known as the theoretical spot rate \( s'_t \). Because movements in the money supply are persistent, forecasts of the ‘fundamentals’ \( x_t \) are relatively smooth. Hence it is found that the actual spot rate \( s_t \) moves much more than the theoretical spot rate, thus decisively rejecting this forward looking RE monetary model (MacDonald and Taylor 1993).

On the basis of panel data studies (e.g. Frankel and Rose 1995, Taylor and Sarno 1998) for the post-Bretton Woods period and using about a century of time series data (Lothian and Taylor 2000), PPP appears to hold in the long run (i.e. relative prices and the exchange rate are
cointegrated). For the backward looking monetary model, ‘failure’ appears to be due to the well-documented instability in the demand for money function and the latter would also invalidate the forward-looking monetary model, even if agents had (Muth) rational expectations.

The UIP relationship provides a clear test of the joint null of risk neutrality and rational expectations (we ignore any Jensen inequality effects). Since covered interest parity holds, (Taylor 1989), UIP implies forward rate unbiasedness with $\beta = 1$ in the following regression:

$$\Delta x_{t+1} = \alpha + \beta (f - s)_t + \epsilon_{t+1}$$

where $f_t$ = forward rate. Empirically it is usually found that $\beta$ is closer to -1 than its value under the null of +1 (Backus et al 1993, Engel 1996). In principle, survey data can be used to separate out the ‘contribution’ of the failure of RE and the risk neutrality proposition but such an approach has not yielded definitive results (Froot and Frankel 1989, Engel 1996, Sarno and Taylor 2002). This forward-rate puzzle is pervasive and has not been resolved by distinct alternative models incorporating a risk premium based on the SDF approach, either using observable macroeconomic variables (Smith et al 2003) or affine models (Backus et al 2001) or cash-in-advance with ‘habit consumption’ in the utility function (Moore and Roche 2002). In short, the behaviour of the exchange rate, even when tested in this relatively direct way, remains largely inexplicable.

### 3. BEHAVIORAL FINANCE

Because of well documented ‘anomalies’ in financial markets which the standard intertemporal model fails to explain, attention has moved to what has become known as behavioral finance. This either involves some form of non-standard behaviour (e.g. non-standard preferences) or the introduction of noise traders who interact with the rational traders (arbitrageurs). There are no ‘free lunches’ in such models but limits to arbitrage imply prices may diverge from fundamental value for substantial periods. Experimental economics and work by psychologists Tversky and Kahneman (1992) provides evidence in favour of the basic postulates of behavioral finance and evidence of a refutation of some of the axioms of expected utility\(^9\). Here we concentrate on theoretical models and empirical evidence from the behavioral finance literature.
For example, Campbell and Cochrane (1997) explain the equity premium puzzle by assuming agents’ maximise lifetime utility where the latter depends on consumption relative to habit consumption (i.e. “keeping up with the Jones’s”). Barberis et al (2001) use prospect theory and the idea of ‘narrow framing’, where agents utility depends on losses in the stock market, as well as intertemporal consumption. This model involves ‘loss aversion’ (i.e. capital losses involve a much greater fall in utility than an equivalent capital gain) and ‘anchoring’, whereby losses which involve a fall in wealth below its previous threshold level, involves an even greater loss of utility. This intertemporal optimising model with non-standard preferences can help explain the equity premium and risk free rate puzzles - as well as avoiding the Rabin (2000) paradox. While therefore it is a legitimate academic pursuit to try and rationalise the New Keynesian structural model in terms of microfoundations based on intertemporal maximisation of utility from consumption, the behavioral finance literature strongly suggest that this may not yield ‘correct’ behavioral equations. For example, the New Keynesian IS curve is in part based on the intertemporal C-CAPM but the latter fails to explain the equity premium puzzle. This should alert one to the fact that such micro-foundations may be deficient.

The behavioral finance literature also emphasizes the interaction between noise traders and boundedly rational agents – rather than the fully rational, representative agent approach which is often embedded in the standard approach. A pervasive stylized fact in the cross section of stock returns is short-run positive autocorrelation and long run mean reversion – this is the basis of momentum strategies and value-growth strategies. Corrected for risk, such strategies appear to give abnormal (risk adjusted) positive returns (e.g. Jegadeesh and Titman 1993, 2001, Chan and Lakonishok 2004). Such a violation of the EMH is impossible in the standard representative agent model. However in the behavioral finance literature, boundedly rational models with heterogeneous agents provide insights into such ‘anomalies’.

For example, the model of Hong and Stein (1999) has ‘newswatchers’ who assimilate private information on fundamentals with a lag, while momentum (noise) traders base their stock purchases on lagged returns. Both newswatchers and momentum traders maximize a CARA utility function but the newswatchers are boundedly rational since they do not condition on past prices (which would be to their advantage) and momentum traders have a finite investment horizon. Market clearing prices are consistent with short term positive autocorrelation and long term mean reversion (when the newswatchers recognize that stocks are overvalued and hence sell). Also, as long as newswatchers take time to assimilate public information into their
valuation calculations, the model is also consistent with the observed under-reaction of stock prices to public news (e.g. earnings announcements, stock repurchases, analysts’ recommendations). The point to note is that representative agent models cannot predict such behavior, as they condition on public news that is immediately available to all market participants. Put another way, heterogeneous boundedly rational agents are sufficient to explain such phenomena.

To the extent that stock prices influence consumption (via a wealth effect) this may have implications for the transmission mechanism of monetary policy. If one wishes to argue that stock market wealth is concentrated and hence such effects are likely to be small, then it is worth noting that the above analysis may well be applicable to the housing market and given the wide spread in ownership of housing wealth, this may have more pervasive effects on consumption (and housing investment).

Behavioral models used to explain two further stock market anomalies, may have a bearing on macroeconomic behavior and hence monetary policy. First, some stock prices (e.g. value stocks) appear to move substantially even though there is no new information about fundamentals and second, some stock returns exhibit co-movement even though there is no co-movement in fundamentals news. Again some degree of bounded rationality is required to explain such results and Barberis and Shleifer (2003) suggest a model based on style investing.

In their model investors allocate their wealth across a limited number of styles and are not particularly concerned about the allocation to individual stocks, within any given style category. In the model of Hong and Stein (1999) above (and in Hong and Stein 2000 and De Long et al 1990) the demand for stocks by momentum (noise) traders depends on their absolute past performance. But Barberis and Shleifer (2003) in their model of style investing, assume that investors momentum demand for stocks of a particular style-X depend on past returns on X relative to past returns on the alternative style-Y (e.g. X = old economy stocks, Y = new economy stocks). Hence, momentum investors move into stocks in style-X and out of style-Y, if past returns on X exceed those on Y - which increases current returns on assets in style-X and decreases the returns on assets in style-Y. Note that the price of Y moves without any cash flow news about the stocks in Y and there is negative autocorrelation at short lags, across assets in the two different styles. But Y eventually rises back towards its fundamental value and hence at long lags the autocorrelation between $\Delta P_{x,t}$ and $\Delta P_{y,t-k}$ (for large-k) will be positive. The latter arises because arbitrageurs’ demand for stocks depends on their estimate of expected returns based on fundamentals (i.e. dividends) and they act as market makers for the ‘switchers’, absorbing their changing demands. The model delivers a market clearing price for all assets but
because the fundamental traders are boundedly rational and do not know the time series properties of the change in demand of the switchers, the market clearing price differs from that when there are only fundamentals’ traders.

It follows from the above analysis that if (say) only one asset in style-X experiences a one-time negative cash flow or demand shock, then the price of other assets in style-X will also experience decreases (unrelated to cash flows), while stocks in style-Y will experience a rise in price (again unrelated to cash flows). Investors move into all securities in a particular style category, if the past style return has been relatively good. Hence there may be positive co-movement in individual asset returns within a particular style category which is unrelated to common sources of cash flows. Evidence for this boundedly rational behavior comes from many sources but two clear cut examples should suffice here. According to the ‘rational’ fundamentals approach, prices of Royal Dutch and Shell which are claims to the same cash flow stream, should move very closely together. But Froot and Dabora (1999) show that Royal Dutch moves closely with the US market, while Shell moves mainly with the UK market. Royal Dutch is traded mostly in the US and Shell mostly in London and hence they may ‘belong to’ these two ‘styles’. Similarly if a stock is added to the S&P500 index (i.e. ‘a style’) then in the future one might expect it to co-vary more with the S&P500 and its correlation with stocks outside the S&P500 to fall –this is indeed the case (Barberis et al 2001).

What relevance might this have for monetary policy? Is it likely that systematic shifts between assets based on relative price changes is sufficient to have a sizeable impact on key macroeconomic aggregates? Even if changes in aggregate wealth are small, narrow framing and loss aversion might provide possible transmission mechanisms. One can envisage individual investors as well as institutional investors (insurance, pension and mutual funds) switching between different investment styles. Individuals switching from stocks to housing after the fall in the stock market over 2000-2003 may have led to overshooting in both markets with the rise in house prices fuelling consumers expenditure. However, the impact on consumption of a fall in stock prices may be small, because individual’s losses in the stock market are concentrated amongst the wealthy (and holdings in pension funds are not salient for investors who are effectively ‘locked in’ over a long horizon).

The switch from stocks to bonds by UK institutional investors over the 2000-2005 period, put downward pressure on long term nominal and real (bond) yields which resulted in real yields falling below 1%, accompanied by an inverted yield curve. The rapid fall in long rates is hard to
rationalize in terms of the standard approach, where changes in expectations of real rates can be expected to be small (in response to changes in long run productivity) and inflation expectations are known to be sluggish. There is a prima facie case for considering 'style effects' as part of the explanation of such effects.\(^{28}\)

*Mental accounting* and *narrow framing* refer to the way people perceive gains and losses and these ideas can also be used to rationalize savings behavior in the high inflation period of the 1970’s and 1980’s in the UK when the standard consumption function became unstable, and the savings ratio increased rapidly. One widely accepted explanation with considerable empirical content was that consumers were concerned about the erosion in the purchasing power of *one part* of their wealth, namely liquid assets. The per period loss is \(\pi L\) where \(\pi\) = rate of inflation, \(L\) = stock of real liquid assets and this variable was found to have considerable predictive power. Consumers therefore paid particular attention to just one aspect of their overall wealth position that appeared salient in times of high inflation.

Another area where the standard approach seems to break down is in the savings-consumption decision which is implicit in the C-CAPM model - since consumption is chosen simultaneously with asset demands and the Euler equation is the first order condition which (in the absence of externalities) delivers an optimal path for savings. However, forced saving in the form of social security and company pension plans are widely accepted and there is much evidence that people undersave for retirement (e.g. Turner 2004, 2005). Also, consumption declines substantially and somewhat discontinuously at retirement – this would not be the case under the C-CAPM/lifecycle model with constant discount rates. Such evidence can be explained by procrastination which results from hyperbolic discounting (O’Donoghue and Rabin 1999)\(^{29}\). This uses the idea from behavioral finance that present consumption is more salient than future consumption. So (with naïve procrastination) the individual (erroneously) assumes that tomorrow will be different from today and that tomorrow, consumption will not appear to be as salient as it appears today. So the individual does not save today and thinks she will save tomorrow. But when tomorrow arrives, current consumption is again salient, so saving is deferred again. Here, rationality and optimal decisions do not follow the standard utility function with exponential discounting – allowance needs to be made for the phenomenon of procrastination and intertemporal inconsistency, as observed in the behavior of individuals (and animals) - who seem far less willing to delay immediate gratification than to commit to such delays in the future\(^{30}\).

\(^{28}\) See Chapter 2 for details.

\(^{29}\) O’Donoghue and Rabin 1999.

\(^{30}\) See Chapter 3 for details.
A recurring theme in the behavioral finance literature is the importance of losses relative to gains (loss aversion, disappointment aversion, max-min outcomes) which helps to explain quite a range of phenomenon - for example, the equity premium puzzle, investors holding poorly performing mutual funds, house owners who have to sell at a loss setting prices 30% higher than those that have experienced prior gains (Genesove and Mayer 2001), investors selling prior winning stocks rather than prior losing stocks (Odean 1998). This has a direct bearing on the conduct of monetary policy at low rates of inflation. If the unemployment-inflation trade-off at low rates of inflation (and hence high levels of unemployment) is permanent and wage cuts are difficult to implement then 'tough' Central Bankers may lock the economy into high rates of unemployment. Prima facie evidence of this phenomena is Canada, Europe and Japan in the 1990s which had persistent high unemployment, yet very low inflation.

The 'standard model' relies on agents optimizing some objective function but it may be that many individuals rely on rules of thumb, as long as such simple rules are not too costly (in which case the simple rule will be changed). Work on mutual funds provide a way of testing the behavior of investors against the classic paradigm of finance theory where individuals are assumed to make rational decisions in relatively frictionless and low information cost markets, which leads to the elimination of inferior financial products and the growth in successful ones. However work in this area has indicated that inertia and even outright irrational behavior may be prevalent among a substantial number of investors.

Take index funds, one of the simplest investment products. Elton et al (2004) show that investors could earn an abnormal return of 1% p.a. from simple ex-ante investment rules that rely on predictability – but they do not take up such opportunities. Also, for actively managed funds, investors' cash blindly follows past raw return winner-funds and such funds do not appear to yield positive future abnormal returns (e.g. Carhart 1997, Sapp and Tiwari 2004). Cooper, Gulen and Rau (2005) show that when a fund changes its name to a hot style (e.g. from 'growth' to 'value', or 'small' to 'large') but does not actually change its style, this results (ceteris paribus) in a large cash inflow, yet the subsequent abnormal performance of this fund is poor. Also, strong persistence in poorly performing funds together with low positive cash inflows (rather than large outflows) suggest that any move towards a competitive equilibrium among loser funds, appears to be relatively slow. So “money is not smart”. Reasons for the continued existence of poorly performing funds include the influence of advertisements, blindly following brokers recommendations, inertia, ignorance, psychological costs (e.g. disappointment aversion,
disposition effect) – in short, an element of irrationality, if your baseline model is one of informed decisions in relatively frictionless and low information cost markets.

The behavioral finance literature has also highlighted the importance of parameter uncertainty in agent’s decision making. A well known result from intertemporal portfolio theory with standard concave (power) utility function and iid returns, is that the proportion of wealth held in risky assets is independent of the investment horizon (Samuelson 1969). A second ‘standard’ result is that when there is quite a small degree of predictability in asset returns a risk averse investor dramatically changes her risky asset holdings (Campbell and Viceira 1999). These results seem at variance with introspection and the facts. However, once we recognise parameter uncertainty in the forecasting relationship any change in the allocation to risky assets is much less - for any given level of predictability (Barberis 2000). There is no reason why such parameter uncertainty might not influence the determination of some macroeconomic aggregates for example the response of consumption to rates of return, wealth and income or the adjustment of wages and prices. For example, part of the reason consumption responds differently to changes in wealth such as stock returns, house prices or changes in (permanent) labour income, is that each source of the change in wealth is subject to different forecast errors and hence estimation risk.

Another area in finance which has yielded insights is to assume that agents do not necessarily know the structure of the ‘problem’ (up to a set of white noise errors, as in a Muth-RE model). Instead, it is assumed that agents have to learn about the true parameters, as more information becomes available. Such an approach can help explain the observed excess volatility in stock prices and stock return predictability (Timmermann 1993, 1996). The potential importance of ‘learning’ in macroeconomic models (see for example, Evans and Honkapohja 2001) is an important area to examine and may have a major influence on the optimal rate of adjustment of the interest rate (Chamberlin et al 2003). Indeed some macroeconomic models explicitly incorporate updating of parameters as agents learn about their changing environment (e.g. Garratt and Hall 1997).

4. ROBUSTNESS

In terms of writing down a ‘consensus’ open economy macroeconomic model, the above empirical work on the exchange rate leaves a rather large lacuna. To mitigate this problem requires policy choices that are robust to plausible alternative models. The difficulty here is that
any results are conditional on the universe of plausible alternative models considered. General conclusions are therefore not necessarily robust!

Nevertheless, Williams (2003) provides some useful insights from the Federal Reserve Board’s quarterly large-scale FRB/US macro-model which encompasses the simple baseline model outlined above. The FRB model incorporates sluggish adjustment, wealth effects as well as income effects in expenditure, forward looking rational expectations by agents and a trade sector influenced by the real exchange rate. (However, asymmetric effects as found for example in ESTAR models are not examined – for evidence on asymmetries see Sayer 2004 and Florio 2004). In the FRB model the objective is to minimise a weighted average of the variance of the output gap and prices (around their target level) subject to a constant on interest rate variability.

\[
\min \lambda \sigma_y^2 + (1 - \lambda) \sigma_{\pi - \pi^*}^2
\]

subject to: \[ \sigma_y^2 \leq k^2 \text{ and } r > 0 \]

where \( \lambda \in (0,1) \) and \( k^2 \) is the constraint on short-term interest rate movements (i.e. Federal Funds rate)\(^{37}\). The short-term interest rate influences the long-rate via the term structure (EH) and also the real exchange rate via UIP. Sluggish price adjustment implies changes in real rates and there are also changes in real expenditure via wealth effects (as well as income and cash flow effects). The simple instrument (Taylor) rule adopted is

\[
r_t = \theta_r r_{t-1} + (1 - \theta_r)(rr + \bar{\pi}_t) + \theta_\pi (\bar{\pi}_t - \pi^*) + \theta_y y_t
\]

where \( r_t \) = nominal rate, \( rr \) = long-run real rate, \( \bar{\pi}_t \) = average inflation of over the last year, \( \bar{\pi} \) = average inflation over the past 3 years, \( \pi^* \) is the inflation target and \( y_t \) is the output gap. \( 0 < \theta_r < 1 \) represents policy inertia, with \( \theta_r = 0 \) a ‘levels rule’, \( \theta_r = 1 \) is the difference rule and \( \theta_r > 1 \) represents ‘super-inertia’. The optimal simple instrument rule has \( \theta_r \) less than but close to unity for all values of \( \lambda_y > 0.2 \) that is, where some weight is given to output as well as price stabilisation. A second interesting result is that alternative simple rules with the interest rate responding to more variables (e.g. including stock prices, unemployment) and the fully optimal policy rule (i.e. where policy responds to all variables in the economy), give nearly the same value for the objective function as the simple rule in [19] (particularly for \( \lambda_y \) around 0.5). This is a strikingly robust result and appears to arise from the term structure equation, whereby a small
rise in short rates (to achieve the inflation target) is transmitted to future short rates and hence to a large rise in current long rates. This is the result of commitment (since private agents know the model and objective function) and have rational expectations.

Using alternative models of the US economy (Levin et al 2003, 2004) it is found that for $\theta_r = 1$, a simple (Taylor) difference rule is more robust with respect to these alternative macro models, than more complex (ad-hoc) rules or a fully optimal rule. The reason for this is that a fully optimal rule on one model may be fine-tuned to a specific part of the transmission mechanism for that model, which may not be present in an alternative model. The simple instrument (Taylor) rule avoids this problem, since most models will incorporate transmission mechanisms working via real interest rates and the output gap.

However, as far as robustness across alternative models is concerned, there is a sting in the tail. If expectations are not rational but backward looking, then high values of $\theta_r$ are associated with poor performance (and may even be destabilising – Ball 1999, Rudebusch and Svensson 1999) and the optimal value is around $\theta_r = 0.5$. So the validity of rational expectations is a crucial assumption for robustness across alternative models. It is also the case that in more complex frameworks such as partial information and especially asymmetric information (Svensson and Woodford 2001) the optimal simple instrument rule under commitment with RE, is more problematic since the optimal path of $r_t$ depends not only on the history of predetermined variables but also on the parameters of the objective function to be maximised.

The above US models have ‘small’ foreign trade sectors and it is not clear that robustness across alternative models under simple Taylor rules, would automatically carry over to economies with a large trade sector, where uncertainty about the exchange rate transmission mechanism is substantial\textsuperscript{38}. However, ‘robustness’ is an important consideration and undoubtedly influences the decisions of Central Bankers on the desirability of interest rate changes, but given that robust simple rules may not be robust across many reasonable models, they cannot be used mechanically. Faced with this evidence, Central Banks are right to use judgement rather than adherence to mechanical application of simple instrument rules.

The ‘new’ Bank of England Quarterly Model (BEQM, Harrison et al 2005) provides a methodology which distinguishes between a ‘core model’ (CM) and a data-adjusted model (DAM)\textsuperscript{39}. The
former contains the economic-theoretical structure, while the latter adds extra variables to provide a reasonably close fit to the data, but whose ‘theoretical underpinnings …. are not yet well understood’ (Harrison et al 2005, p.61) – such as the house-price to consumption link or credit market imperfections. While this model building procedure may be useful, Pagan (2005, p.192) notes that “I must confess to a desire to see the separate responses from both the BEQM-core and (full) BEQM in order to gain some appreciation of the contribution of the non-core components to these responses” and although summary tracking performance using historic averages was valuable “it might well be supplemented with information relating to particular episodes. Thus the tracking performance in the period after 1997, when there was a strong exchange rate, is of interest.” (Pagan 2005, p.193). One might infer from this that it is not entirely clear how much of the tracking performance of the model is due to the microfoundations of the BEQB-core relative to that of the DAM in explaining the macroeconomy over the 2-5 year horizon used in the implementation of monetary policy – this may be the price one pays for relying on the ‘standard model’ as the ‘core’ instead of giving equal theoretical and empirical prominence to other pervasive factors that are required to ‘explain’ the macroeconomy. One might add that it is precisely when somewhat abnormal circumstances occur that the MPC might glean much from having a theoretical framework that attempts to rationalize such ‘anomalies’. We have argued that behavioral finance provides a useful starting point for examining such factors.

So, policy makers do not use mechanical feedback rules and certainly do not use fully optimal rules since with the latter it is almost impossible to communicate the logic of decisions, since they are so convoluted and complex. Despite all that has been written on the latter topics perhaps the clearest statement of what the MPC may be doing is from an ex-MPC member Charles Goodhart who states “When I was a member of the MPC I thought that I was trying, at each forecast round, to set the level of interest rates, on each occasion, so that without the need for future rate changes prospective (forecast) inflation would on average equal the target at the policy horizon.” (Svensson 2003, p429) – Svensson refers to this as a commitment to a targeting rule.

The empirical evidence from ‘small’ reduced form models such as VAR’s, VECM’s including those that incorporate leading indicators with a priori economic content (e.g. term spread, default spread, dividend yield) have failed to provide useful and reliable forecasting models. For example, in an exhaustive study of 7 developed economies and 43 potential variables Stock and Watson (2001) find that such relationships have substantial parameter instability, so that a good
within sample ‘fit’ often implies a poor outside sample forecast performance and this result is not in general altered by using time-varying parameter models or non-linear models. Let me sum up with their rather damning quote “These observations point to a deeper problem than measurement: that the underlying relations themselves depend on economic policies, macroeconomic shocks, and specific institutions and thus evolve in ways that are sufficiently complex that real-time forecasting confronts considerable model uncertainty”.

Given the above evidence it is not surprising that a fixed parameter ‘standard model’ does not provide an adequate and reliable quantitative analysis of the macroeconomy ex-post or in terms of ex-ante forecasting. It is time for macroeconomists to take a wider view than the standard approach when seeking to model agents’ behavior and the behavioral finance literature provides fertile ground for an extension of this analysis.

In the meantime, monetary policy based on inflation targeting with maximum transparency can in principle take account of ideas from behavioral finance, when exercising judgement. Fully optimal rules or mechanical use of instrument rules do not seem to be practical alternatives when one takes account of behavioral models and evidence from financial markets, which require assumptions outside those of the standard model.

Of course, ideas from behavioral finance such as salience and narrow framing may feature in policy makers’ judgements. For example, it may be reasonable to assume that the PEAPC applies at very low levels of unemployment and hence would produce accelerating inflation, yet the accelerationist hypothesis may not apply at very low levels of unemployment – here the inflation-unemployment trade off may be permanent as inflation is less salient and sticky prices may be ‘near rational’. Narrow framing may also have played a part in UK policy makers’ views about the impact of inflation on consumers’ expenditure in the 1970-80s and the impact of house prices on consumers expenditures in the 1990s. What is now required is an aggressive defense of such judgement supported by models and evidence from the behavioral finance literature - rather than undue reliance on the ‘standard model’, as the only logically coherent and defensible approach.

5. CONCLUSIONS

There are some markets such as the bond market where rational expectations plus risk neutrality are not wholly at variance with the data. The behaviour of stock prices is not as well understood, which may be due to non-standard preferences, a breakdown of rational expectations or the
presence of noise traders and boundedly rational arbitrageurs. The behaviour of the spot-FX rate is perhaps still the least understood macroeconomic variable. So, our knowledge of the transmission mechanism of monetary policy is far from complete.

The move from monetary targeting to Taylor type instrument rules provides a more robust ‘framework’ for monetary policy - but Central Bankers are well aware that inflation targeting involving judgement and policy actions which are transparent, dominates the ‘fixed rules’ approach.

We have argued that once one leaves the narrow preserve of conventional macroeconomics there is mounting evidence that the standard competitive general equilibrium model with intertemporal maximizing agents with rational expectations, fails to explain well documented and important anomalies in the financial economics area. This suggests that economists studying the macroeconomy should examine the implications of non-standard preferences, heterogeneity and bounded rationality in their models – and staunchly defend such models if they prove to have empirical content on a par with rival models. Such an approach may be far more important in aiding monetary policy particularly over horizons of 2-5 years, than developments in the ‘standard model’.

There has and will continue to be much ‘innovation’ in macroeconomics and progress at a technical level has been substantial\textsuperscript{44}. ‘Reasonable’ models or paradigms tend to be persistent – they continue to exist even when there is strong evidence against them. Perhaps a (somewhat extended) metaphor provides the best overall conclusion for the clash between alternative theoretical models and the practice of monetary policy. Monetary policy has gone through many fads and fashions and there have been plenty of ‘cute models’ vying for the spotlight. But the truth is that macro-data cannot unambiguously discriminate between alternatives. So, as far as monetary theory is concerned, it is not that “the Emperor has no clothes”, it is that he has too many - and no-one can agree which fit the best. Although ‘haute-couture’ designer models have often dominated the academic catwalk, independent Central Bankers seem more suited to an eclectic style – namely, an inflation targeting framework. Perhaps the latter has done more for economic stability, than all of the Emperor’s ‘new clothes’.
Acknowledgements

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Endnotes

1. Note that the standard model, sometimes introduces additive quadratic terms in the change in decision variables – to provide a lagged dependent variable, which introduces some inertia. There are important contributions to macroeconomic theory which do not use the standard model and also lie outside the behavioral finance literature – these have played a major part in rationalizing the short run impact of monetary policy on output and the possibility of a permanent long run trade off between inflation and unemployment. These contributions mainly come under the heading of models with asymmetric information (including efficiency wages), monopolistic competition and menu costs – see the excellent discussion in Akerlof (2002). In this paper we concentrate on the potential relevance for macroeconomics of ideas from the behavioral finance literature.

2. This approach gives the instrument (usually a short term interest rate) as a known function of the information available to the central bank. The best known simple instrument rule is the Taylor rule (1993). In its clearest formulation, the Central Bank should commit to the rule and automatically follow it – there is no room for judgement.

3. Svensson (2003) refers to this as a “commitment to a targeting rule” and is discussed further below.

4. Politicians are often derided for being ideological, advocating policies without sufficient evidence, jumping on bandwagons and are therefore held in low esteem. Macroeconomists must be careful to avoid such outcomes.

5. The Bank of England’s current view reflects this as “the relationship between the monetary aggregates and nominal GDP in the UK appears to be insufficiently stable... for the monetary aggregates to provide a robust indicator of likely future inflation developments in the near term”. “In other words, money matters, but not in such a precise way as to provide a reliable quantitative guide for monetary policy in the short to medium term” (Monetary Policy Committee 1999). We particularly like the use of “insufficiently stable” rather than “unstable” and the beautifully crafted diplomatic statement dealing with “money matters”.

6. An error correction model is of the form, $\Delta m_t = \gamma \Delta Y_{t-1} - \alpha (m_{t-1} - m^*_t)$ where $m^*$ is the long run money demand depending on the level of the $X$ variables (e.g. income, prices and asset returns) and $m_t$ is actual money demand. For debates on testing the Lucas critique in the context of the demand for money see for example, Hendry (1988), Cuthbertson (1991) and Rudebusch (2002).


8. With some levity, we have heard it said that macroeconomics has had more revolutions than Haiti – see the list of ‘new’ macroeconomic models in footnote 2 of Taylor (2001).

9. This provides the basis for inclusion of financial variables such as interest rates, the term spread, default spread and stock prices as leading indicators or, as explicit forcing variables in (structural) VAR models.

10. These variables cannot be additive since then they do not appear in the first order conditions.

11. It seems that the equity premium puzzle cannot be rescued by using the conventional model with a generalized expected utility function which allows the separation of intertemporal substitution and the risk aversion parameter (Epstein and Zin 1989,1991). The incomplete markets model of Constantinides and Duffie (1996) can in principle explain the equity premium and risk free rate puzzles but the empirical validity of some of the assumptions is questionable (see Cochrane 2001) and this is not a representative agent model.

12. All we require is that utility is an increasing concave function of wealth.
13. The Rabin paradox does not apply to utility functions with loss aversion (Kahneman and Tversky 1979) or disappointment aversion (Gul 1991). Another famous example of a breakdown of expected utility maximization from early experimental psychology is the Ellsberg (1961) paradox – for an overview see Cuthbertson and Nitzsche (2004).

14. The evidence on mean-reversion and predictability in aggregate stock returns is voluminous, but summaries of this work can be found in Cochrane (2001) and Cuthbertson and Nitzsche (2004). Summers (1986) is the classic paper that demonstrates that the null (of a random walk in stock prices) has low power against a slowly mean reverting alternative, where for example, if the latter applies yet can be detected only 50% of the time, it would nevertheless result in prices deviating from fundamentals by about 30% (for 35% of the time).

15. Space constraints imply that we cannot discuss the anomalies literature which documents many practical instances of the limits to arbitrage. If there are no close substitute securities available then miss-pricing requires risk averse arbitrageurs and systematic fundamentals risk whereas if a close substitutes exist, then miss-pricing requires risk averse arbitrageurs with a finite investment horizon, coupled with systematic noise trader risk – see the excellent survey by Barberis and Thaler (2003).

16. This statement is somewhat contentious. Sarno et al (2005) provide a comprehensive overview of the US evidence and find that tests of the cross-equation restrictions are formally rejected particularly for rates of less than 3 years maturity – even when the volatile interest rate period 1979:01-1981:12 is excluded. Two questions remain in our minds on the interpretation of these results. First, the data on spot yields (as is standard) are derived from a cubic spline function – would measurement error be important in testing the highly non-linear parameter restrictions? Second, a prediction of the EH is that the long run coefficient between the long rate and short rate is unity. Suppose the empirical result were a coefficient of 0.99 with a standard error of 0.005, then the theory is (marginally) rejected (at a 5% significance level) - but we feel most economists might claim that this result does not constitute an economically significant departure (e.g. you may not be able to make abnormal profits by trading on this ‘rejection’ of the EMH) and hence the theory has some merit. This is part of a wider argument about what constitutes a ‘good theory’ on which to base policy decisions – which clearly involves judgment.

17. The behavioral finance literature would emphasize bounded rationality, so that variations in term premia are viewed as being less salient than uncertainty about revisions to future short rates.

18. Indeed the Theil U statistics $U = \frac{RMSE_{fcm}}{RMSE_{RW}}$ lie mainly between 0.98 and 1.02 so the forecast improvement for the fundamentals model over the random walk (RW) model is rather marginal. Sarno (2005) provides an up-to-date survey of ‘puzzles’ in exchange rate economics and concludes that "With respect to the ability of empirical exchange rate models to explain and forecast the nominal exchange rate, the literature is still somewhat in the dark".


20. Both of these formulations have marginal utility being non-separable in current consumption and an additional variable Z. In Campbell and Cochrane, Z = previous consumption and in Barberis et al., Z= prior losses in the stock market – both can be interpreted as recession variables, so risk aversion rises in recessions (for an overview see Cuthbertson and Nitzsche 2004).

21. Conversely, if you already have cumulative winnings, then a small loss does not involve as great a reduction in utility compared with a loss which pushes you below your initial (reference) level of wealth – you are then said to be "playing with the house money". This puts a ‘kink’ in the utility function which represents ‘extreme’ loss aversion. Previous cumulative winnings is an integral control variable in the utility function, whereas the change in wealth is derivative control variable.

22. A typical momentum strategy involves buying past winner stocks (e.g. top decile performers over the last 6 months) and short selling recent loser stocks (e.g. bottom decile), using a holding period of six months and rebalancing monthly. The value-growth strategy is to buy long term past loser stocks and short-sell long term past winner stocks (i.e. ‘buy the dogs and sell the stars’) and hold for between three to five years (and usually rebalancing monthly or quarterly).
23. If we allow **fully informed** ‘smart money’ traders in the model then the qualitative results still hold providing the risk tolerance of the smart money traders is finite.

24. Even when more sophisticated arbitrageurs are introduced into the model so they understand the time-variation in the momentum traders demands, this does not necessarily reduce the size and persistence in the mispricing. This arises because arbitrageurs do not sell when price is above fundamental value – they **buy**, knowing that the increasing demand by feedback traders will raise the price even further, after which the arbitrageurs exit at a profit. In other words the arbitrageurs mimic the behavior of the momentum traders after a price rise (or fall).

25.¹ In the Hong and Stein (1999) and De Long (1990) models, good news about asset-\(i\) (\(i \in X\)) only affects the price of asset-\(i\) and not the prices of other assets in the same style (\(i \in X\)), nor assets belonging to style-\(Y\). The predictions of these models differ in this respect.

26.¹ Reading the *Financial Times* or other ‘trade journals’ would certainly strongly suggest this is the case – and the impact on actual asset allocation decisions is also clearly documented (see for example, the survey by the Investment Management Association 2005). Shiller (2001) documents the possible causes of such shifts in the case of the stock market in the 1960s and the late 1990’s ‘new era’ internet bubble – he emphasizes the interaction of ‘style’ investing and the slow dissemination of information, particularly among individual investors.

27.¹ The increase in the real value of housing also provides collateral for additional borrowing (equity withdrawal) and hence higher consumers’ expenditure (Aoki et al 2002, Campbell and Cocco 2004).

28.¹ Large deficits in company pension funds and the levy to be paid to the Pensions Protection Board imply that some companies are using current profits to reduce pensions’ deficits. To the extent that bond returns are less volatile than stock returns, this may reduce the riskiness of the pension portfolio and is also part of the reason for an increased demand for bonds.

29. Hyperbolic discounting assumes that viewed from time-\(t\), the trade-off between consumption at \(t\) and \(t+1\) is much higher than the trade-off at two adjacent dates more distant in the future (i.e. between \(t+k\) and \(t+k+1\), for \(k>1\)). Put another way, the ‘near future’ carries more weight than the ‘distant future’.

30.¹ Such ideas are the basis of national savings schemes that are compulsory, or if voluntary have automatic enrolment, an automatic default contribution and sometimes have individual’s making a pre-commitment to increasing the proportion of income which will be saved in the future - see Laibson, Repetto and Tobacman (1998) and Thaler and Benartzi (2004).

31.¹ This is usually referred to as the disposition effect.

32. Note that Japan actually suffered falling prices. Resistance to wage cuts may be due to a disposition /loss aversion effect which is re-inforced by concepts of fairness (Akerlof 1982, Rabin 1993). Although wages can rise because of productivity increases, some ‘unlucky’ firms will experience negative productivity shocks and should therefore cut nominal wages at very low inflation rates. For the MPC of the Bank of England, changes in interest rate policy must avoid “undesirable volatility in output” and persistent unemployment could influence interest rate policy and this would be one reason for deviating more than 1% from the 2% inflation target – the reasons for which, would have to be communicated in the Governor’s letter to the Chancellor.

33. Cosmetic name changes are those which do not result in a change in style as measured by the change in factor loadings on the Fama-French (1996) ‘small minus big’ SMB and ‘high minus low book-to-market value’ HML, factors. If the fund’s style factor loading on SMB and HML (measured over the 2 years after the name change) does not exceed that of the quintile BMV and size sorted control portfolio ‘break points’, then the name change is ‘cosmetic’.

34. Instances of ‘non-rational’ behaviour for other financial decisions is widely documented in the behavioral finance literature – an excellent recent survey is Barberis and Thaler 2003.

35. Although money chases extreme ‘past winner’ mutual funds (i.e. tournament hypothesis), this does not change the proportion of risky assets held, since this mainly involves a switch from other mutual funds which have a relatively moderate past performance.
36. It might also explain why individuals frequently adopt simple rules of thumb rather than optimal strategies. A classic example here from the behavioral finance literature is the “1/n heuristic” whereby individuals faced with (401K) savings plans that predominantly consist of stock funds end up owning mostly stocks, while those presented with choices involving fixed income funds end up mostly holding bonds – even though the risk appetite and life cycle mix of participants is the same for both types of funds. It may be that given the uncertainties surrounding the measurement of inputs (e.g. expected returns, covariances) that the chosen portfolio is perceived ex-ante to be ‘close to’ optimal. Markowitz is reported as using the 1/n heuristic in order to “minimize my future regret” (Benartzi and Thaler 2001).

37. This is the limit, as the discount rate approaches unity, of the more usual intertemporal loss function involving a quadratic in the deviation from target and the output gap – see equation 3.

38. Simple instrument rules where the interest rate also responds to either the exchange rate or stock prices seem to provide at best, only a modest improvement over the simple Taylor rule in the text (see for example, Bernanke and Gertler 2001, Taylor 2001). At an informal level Wadhwani (1999), Goodhart (2000) and Bean (2003) indicate that asset prices (particularly house prices and the exchange rate) should influence decisions on interest rates, but not in a mechanical way via a pre-commitment to an instrument rule.

39. The terms are found in Pagan (2005), who also considers a third type of model the ‘operational model’ which uses extraneous information about the future (e.g. rapid house price inflation) when making an ex-ante forecast. Of course all these ‘models’ will be embedded in a single model. Naturally any ‘core model’ will satisfy accounting identities and may set limits on the long run behavior of certain variables (e.g. household net debt should not rise indefinitely) – although the relevance such ‘long run’ constraints for practical monetary policy is debatable. Also, note that any model can produce any forecast you like (subject to accounting identities) by ‘intercept’ or ‘residual’ adjustments. This was often the method used in producing ‘model forecasts’, before transparency about models ‘run’ by institutions such as Central Banks and government fiscal authorities such as the Treasury became the vogue. When forecasts are explicitly stated as embodying judgement, so the model merely “provides the Committee with a more flexible and coherent framework to aid its economic deliberations” (Bank of England 2004) – then there is less need for such ‘adjustments’ to the model, since they then effectively ‘become off-model’ or judgemental adjustments.

40. The ‘gap’ between the MPC’s view of the workings of the macroeconomy and a formal ‘standard model’ may be inferred from the MPC’s account of the transmission mechanism (Monetary Policy Committee 1999). For example, “The precise impact on exchange rates of an official rate change is uncertain …” (p.4). Official rate changes can influence expectations about the future course of real activity … and the direction in which such effects work is hard to predict, and can vary from time to time” (p.6). On the impact of interest rate changes on output and inflation, “there is a great deal of variation and uncertainty around these average time lags” so “the impact of monetary policy is subject to long, variable and uncertain lags” (p.9). The new BEQM is an interesting yet contentious approach which uses the standard approach to give predictions from the ‘core model’ and any ‘ad-hoc’ elements only influence short run deviations from the predictions of the core model - the rationale is clearly set out in Harrison et al. (2005).

41. Optimal control has its genesis in engineering problems (e.g. placing a probe on the moon). Readers might like to note that such an approach was considered an insufficient basis for macroeconomic policy in the UK as early as 1978, partly because the structure of the macro-economy could not be known with sufficient precision. “There are difficulties eg. in establishing the set of preferences in mathematical terms and taking into account human behaviour, unwillingness of ministers to commit to decisions in advance of events and the possibility of changing your mind. The Committee conclude that the use of optimal control theory is feasible and of value but is not the single most important priority at the moment in the development of modelling and forecasting practice” (Ball 1978). Svensson (2003) argues that fully optimal rules are too complex to be verifiable.

42. A nice stylized example of inflation targeting was given by the Governor to the Bank of England, in the Maradona theory of monetary policy (King 2005). In the 1986 Argentina-England World Cup match Maradona ran half the length of the pitch virtually in a straight line but managed to beat several England players and score. The English players had the expectation that Maradona would move to the right or left, and re-acted accordingly - hence, he could continue in a straight line. In a similar fashion the inflation targeting framework, if credible, allows the Bank to keep inflation on target without adjusting interest rates. Private agents assume that if inflation is off-target the Bank will adjust interest rates to bring it back on
target, so agents pre-empt this in their own decisions, which pushes inflation back on target without any change in interest rates.

43. Akerlof and Yellen (1991) provide a model of imperfect competition and efficiency wages where some firms follow a rule of thumb and do not adjust prices after a demand shock. These firms suffer losses that are “second order” in terms of profits but the impact on output is “first order” – so ‘simple rules’ can be near optimal/rational.

44. For an excellent summary of the wide variety of different approaches in macroeconomic modelling see Harrison et al (2005). These include inter alia VARs, structural VARs, VECM’s, Dynamic Stochastic General Equilibrium models DSGE as well as more ‘conventional’ large scale models used by some Central Banks.
REFERENCES


Figure 1: Log Dividend-Price Ratio: Constant Real Returns Model: UK Data (1920 – 2001)
Figure 2
Actual and theoretical spread (2-year, 1-month spread)
UK data 1976-2002

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