An estimated DSGE model of energy, costs and inflation in the United Kingdom

Summary of Working Paper no. 432 Stephen Millard

The job of monetary policy makers is to set monetary policy so as to achieve their goal of low and stable inflation. In order to carry this out, it is important to understand what drives inflation and how changes in monetary policy feed through the economy into inflation. But no single model can capture all aspects of reality. This is why many central banks have used, and continue to use, a variety of macroeconomic models to help in their understanding of inflation. The main purpose of this paper is to estimate a model of the United Kingdom that, unusually, includes an energy sector. It could in principle be used as another input within a policymaker's 'suite of models'.

The standard model of inflation suggests that it is driven by lagged and future expected inflation and movements in costs. One important cost for most producers is the cost of energy. So, inflation will be affected by movements in energy prices. In addition, to the extent that consumers use energy themselves, movements in energy prices will have a direct, and immediate, effect on consumer price inflation, which is not necessarily captured by standard models. The novelty of this paper, relative to previous work, is that the model takes seriously the effects of movements in energy and other costs on inflation. The goal is to produce a macroeconomic model that can be used to analyse quantitatively the effects on inflation of many temporary shocks, including but not limited to energy prices as well as how monetary policy can respond to such shocks. Furthermore, estimating the model enables us to evaluate how these shocks have evolved over time and the implications of this for explaining movements in output and inflation.

The basic building blocks of the model are standard. The main complication is that there are three consumption goods: non-energy output, petrol and utilities (which can be thought of as a combination of gas and electricity). Each of these consumption goods is produced using different combinations of five inputs: labour, capital, imported (non-energy) intermediates, oil and gas. The prices set by the producers of these goods are sticky. Demand for oil and gas over and above what we produce has to be met from abroad. The central bank affects aggregate demand via movements in interest rates. How this level of aggregate demand translates into demand for each of the goods is determined by consumers' preferences and relative prices. Finally, the model adds a government that 'eats up' some of the non-energy good and levies taxes as well as a specific duty on petrol.

The estimates suggest, not surprisingly, that petrol prices are highly flexible, utility prices are quite flexible, while non-energy prices, on the other hand, are very sticky. The relative stickiness of prices in the three sectors are in line with survey and other evidence for the United Kingdom. In terms of the shocks, the estimates suggest that the productivity shock is fairly persistent but the others much less so; the model is able to explain persistence in the data without having to resort to extremely persistent shocks. The estimated standard deviation of monetary policy shocks is very low, not altogether surprising given that the model was estimated over the inflation-targeting period. But, the domestic demand and investment-specific technology shocks are highly volatile over this period. Finally, the estimates suggest that the model including energy prices is better able to explain UK macroeconomic data than an otherwise identical model that does not include energy prices.

Given these estimates, it is possible for the model's user to apply the model quantitatively to UK policy issues. The paper has shown how this could be done by examining the effects of many different shocks on inflation and by decomposing recent movements in output and inflation into those parts caused by each of the model's structural shocks. It found that the fall in gross non-energy output from 2008 Q2 to 2009 Q3 was driven by three shocks: to productivity, to world demand and to the domestic risk premium, proxying the effects of the recent financial crisis. The risk premium shock also put downwards pressure on inflation during this period while the productivity shock was putting upwards pressure on inflation. The world demand shock, by contrast, was much less important in explaining the behaviour of inflation over this period.

The impact of permanent energy price shocks on the UK economy

Summary of Working Paper no. 433 Richard Harrison, Ryland Thomas and Iain de Weymarn

The world price of energy has risen dramatically in recent years. This rise has been persistent. Energy has an important role in all economies, affecting both demand and supply, in ways that depend upon energy intensity and the degree to which an economy produces energy as a raw material. For economies that are significant net producers or net consumers of oil and natural gas, persistent price rises can imply potentially large wealth effects in the absence of full international risk-sharing. The United Kingdom is an interesting case as it represents an economy on the transition path from being broadly self-sufficient in energy to being one that is a significant net importer. Thus in this paper, we analyse the implications of permanent energy price shocks for the UK economy.

To analyse the impact of such shocks we build a dynamic general equilibrium model. This approach allows us to articulate theoretically the wide variety of channels through which energy prices might affect demand and supply by making a careful analysis of how shocks propagate through the economy, a process that inevitably takes time. The calibration process we use involves the careful choice of critical parameters that allow us to match key properties of the UK data. On the supply side, we model how primary energy inputs such as oil and natural gas are used to produce final energy goods such as petrol and electricity and gas distribution. We also model the way that final energy goods enter the production process of non-energy goods. We allow for the direct use of energy in the production process and for energy prices to influence the utilisation of the capital stock. On the demand side we model the substitution in household consumption between final energy goods and non-energy goods. To calibrate the model we construct a UK data set using the National Accounts Input-Output Supply and Use Tables. This allows us to gauge the quantitative importance of the different channels.

We examine how the various channels in the model contribute to the overall response to a permanent energy price shock. We show the quantitative sensitivity of inflation and output responses to the following key assumptions and judgements:

(i) the degree of nominal rigidity in price and wage-setting;
(ii) the monetary policy response, both domestic and overseas;
(iii) the assumption about self-sufficiency and its impact on the real exchange rate and import prices;
(iv) the degree of real wage resistance and the impact on the labour market; and
(v) the impact on the level and utilisation of the capital stock.

We show that the impact of higher energy prices depends significantly on the monetary policy response to higher energy prices, both here and abroad. When policy does not fully accommodate the shock the degree of nominal wage rigidity is important in determining the extent to which the indirect effects of higher energy prices are able to offset the direct effects of higher petrol and utility prices on inflation. Indeed negative effects on inflation from higher energy prices are possible if these offsetting indirect effects are not synchronous with the direct effects. The degree of self-sufficiency in energy is also important as it leads to significantly different effects on consumption and the real exchange rate. On the supply side, we find that the effects on potential supply are not likely to be large unless there is significant real wage resistance and higher energy costs affect the utilisation of the capital stock.

Our model only explores the effects of permanent shocks in a theoretical model. In a companion paper, the model is estimated on actual data to see how well it describes the UK experience.

Evolving UK and US macroeconomic dynamics through the lens of a model of deterministic structural change

Summary of Working Paper no. 434 George Kapetanios and Tony Yates

This paper contributes to a body of work that has sought to describe evolutions in the dynamics of inflation and output in developed economies. That work has been preoccupied with documenting changes in the volatility of inflation and output, changes in the persistence of inflation, and changes in the impact of a monetary policy shock, among other questions.

These facts have been deployed to try to diagnose the causes of the Great Moderation; document evolutions in real and nominal frictions in the economy, and to understand their ultimate causes. The tool of choice for studies of structural change of this kind has been an econometric model that views the parameters that propagate shocks as themselves evolving over time, and behaving as though they were random, but mean-reverting process. This paper applies a very different tool to the same set of questions. We posit that the parameters that propagate shocks evolve smoothly and non-randomly, and may not necessarily be attracted back to the mean.

Why the need for a different tool to the industry standard? First, we provide some suggestive Monte Carlo evidence that models of deterministic structural change do a good job of characterising that change even when in truth that change is random in origin. Second, whether a deterministic or random parameter model is the best choice will depend on the nature of the task in hand. In the macroeconomic dynamics literature that we apply the tool to, there are reasons for at least studying what this deterministic model generates; economic theory is generally silent about the true causes of parameter change, so that we cannot choose on those grounds which econometric tool to use. This theory is however also silent about whether such change should be mean-reverting, so on these grounds it may be desirable to look at evolving macroeconomic dynamics through the lens of the deterministic model which allows structural change to be non mean-reverting.

With these motivations in mind, we take the tools to UK and US data on inflation, GDP and policy interest rates. We document several findings of interest. First, we note significant reductions in inflation persistence (using univariate models) and predictability (using multivariate models). Second, we estimate that changes in the volatility of shocks were decisive in accounting for the Great Moderations in these two countries. Third, the evidence suggests that the magnitude and persistence of the response of inflation and output to monetary policy shocks has fallen in these two countries.

Preferred-habitat investors and the US term structure of real rates

Summary of Working Paper no. 435 Iryna Kaminska, Dimitri Vayanos and Gabriele Zinna

US long-term interest rates have fallen substantially since 2000. The decline continued during 2004–05, at the same time that US monetary policy was being tightened. This phenomenon was identified as a 'conundrum' by Alan Greenspan, the Federal Reserve Chairman at that time. Understanding the causes of low long real rates is important for financial stability, because low interest rates may represent a potential threat to the health of a financial system. Indeed, prior to the financial crisis in 2007, excessively low interest rates may have contributed to the so-called 'search for yield' environment, whereby investors' demand for risky assets increased in order to secure returns comparable to those seen in the earlier era of higher bond interest rates. Combined with excessive credit creation and poor investment decisions, the 'search for yield' undermined the stability of the financial system profoundly.

Until now, the low rates phenomenon has not been fully explained and remains a puzzle. Monetary explanations were unable to rationalise the 'conundrum', and the view that bond yields had benefited from a more stable and credible regime for monetary policy fails to match the evidence: in reality, only yields on Treasury bonds declined, while equity yields and global equity premium were increasing. Instead, we argue that large amounts of savings flowing into US Treasury securities have pushed down on US long rates. Thus our hypothesis is in line with that strand of the literature focusing on the role of saving (the so-called Asian 'saving glut') and 'global imbalances' to explain the conundrum. This literature on global imbalances suggests that US interest rates were lower because of capital flowing to advanced economies, and the United States in particular.

However, the macroeconomic literature on 'global imbalances' is mostly theoretical and/or lacks a quantitative structural analysis to explain the fall in bond yields. To try to improve the analysis it is natural to look at standard finance bond pricing models. Such models assume that there are no risk-free profits to be made by trading between bonds at different maturities (in other words, there are no arbitrage opportunities). The assumption of no arbitrage is crucial because it allows for the decomposition of interest rates into expectations of future short (ie risk-free) rates and term premia. These models are also based on the assumption that the economy consists of identical (representative) agents whose actions cannot affect prices.

In this paper, to analyse how quantities (demand for Treasuries by foreign investors) can affect the term structure of yields we have to deviate from the standard finance approach of modelling the real term structure. In particular, while we maintain the key assumption of no arbitrage, we assume that there are two different types of investors: those who buy bonds of specific maturities also for reasons other than returns (preferred-habitat investors) and those who trade bonds at different maturities for returns considerations (arbitrageurs). The interaction of preferred-habitat investors and risk-averse arbitrageurs determines equilibrium interest rates. We conjecture that, because foreign central banks are a major player in the US Treasury market and because they buy US long-term Treasury securities for 'necessity' as part of their reserve accumulation strategy, foreign central banks can be (partly) identified as preferred-habitat investors.

We estimate a model of the term structure of real interest rates, derived from US Treasury Inflation-Protected Securities (TIPS). Our results show that the decline in long rates in 2004–05 is explained by the drop in the term premia. And, in turn, term premia are mainly driven by a rising preferred-habitat demand. We show that international reserves, foreign official holdings of longer-term US Treasuries and other proxies for foreign reserve demand may all be possible explanations for the increasing preferred-habitat demand. We also find that the interaction between arbitrageurs and preferred-habitat investors (demand pressure) matters. In other words, arbitrageurs require a higher compensation for trading away arbitrage opportunities, which may arise as a result of foreign central banks' purchases of US Treasuries, when their capital is particularly low. So, the timing of reserve accumulation is important to determine its impact on equilibrium rates.

It is also worth noting that the model set-up assumes that arbitrageurs have a constant degree of risk aversion. This allowed us to work with a more tractable model. But, looking ahead, a time-varying degree of risk aversion might increase the performance of the model, eg during the crisis when arbitrageurs' trading activities were impaired.