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An open-economy macro-finance model of international interdependence: The OECD, US and the UK

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ABSTRACT

This paper develops a multi-country macro-finance model to study international economic and financial linkages. This approach models the economy and financial markets jointly using both types of data to throw light on such issues. The world economy is modelled using data for the US and aggregate OECD economies as well as the US Treasury bond market using latent variables to represent a common inflation trend and a US real interest rate factor. We find strong evidence of global effects on both the US and UK, calling into question the standard closed economy macro-finance specification. These economic linkages also help to explain the co-movement of yields in the US and UK Treasury bond markets.

1. Introduction

As recent developments in commodity and credit markets demonstrate, the global economy is becoming increasingly integrated. The spillovers from the United States to smaller economies have been extensively studied. Event studies show that US recessions usually coincide with significant reductions in global growth. Panel growth regression analysis (e.g., Arora and Vamvakidis, 2006) finds evidence of large output spillovers from the US to other economies. Kose et al. (2003) and Kose et al. (2005) show that common shocks such as changes in oil prices or asset prices play an important role in explaining business cycles for the industrial countries. Yang et al. (2006) and others reveal the significance of inflation spillovers. This paper develops a multi-country macro-finance modeling framework to study such international effects. This approach allows bond yields to reflect macroeconomic variables, either through Kalman filters that reflect underlying inflation (Ang and Piazzesi, 2003; Dewachter and Lyrio, 2006; Joyce et al., forthcoming; Spencer, 2008) or through the jump diffusion affecting the spot rate (Jiang and Yan, 2009). Bond yields help inform the specification of the macroeconomy, suggesting for example that although macroeconomic variables provide a good description of the behavior of short rates they do not provide an adequate description of long-term yields. This observation has prompted the use of Kalman filters to reflect the changes in long run inflation expectations, allowing the model to be used in a global setting in which there are both latent and observable macroeconomic factors.

Macro-finance models have until now focused on the US, assuming that it is a closed economy. Macro-finance models of countries such as the UK (Joyce et al., forthcoming) have also been modelled in this way despite their open trade and financial structures. This paper adapts the macro-finance model in a way that allows us to test the validity of the closed economy assumption. Our specification consists of two systems. The first system represents the world economy using a reduced form specification with both OECD and US variables. We identify a common non-stationary world factor that drives OECD inflation and US inflation and interest rates and model this using a latent variable, with another representing real interest rate movements. This model reveals strong global effects on the US. We then extend the model to explain US Treasury yield data using the standard arbitrage-free approach. The second system is a model of the UK economy and Treasury bond market that allows for global influences and is estimated simultaneously with the first.

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Table 1
Data summary statistics: 1979 Q1–2007 Q1.

	g^{**}	π^{**}	g^{*}	π^{*}	r^{*}	g	π	r
Macro variables								
Mean	−0.553	3.872	−0.763	3.998	6.089	−1.188	4.817	8.142
Std.	1.510	2.614	1.951	2.728	3.273	2.505	3.605	3.484
Skew.	−0.259	1.732	−0.896	2.050	0.819	−0.305	2.027	0.499
Excess Kurt.	0.493	2.288	1.675	3.718	0.571	−0.155	4.038	−0.977
ADF	−2.967*	−1.749	−3.367*	−2.248	−1.804	−2.999*	−1.867	−1.624
	y^*_4	y^*_8	y^*_{12}	y^*_{20}	y^*_{28}	y^*_{40}	y^*_{60}	
The US Yield (subscript is the number of months to maturity)								
Mean	6.535	6.813	7.005	7.278	7.469	7.635	7.955	
Std.	3.300	3.214	3.101	2.965	2.861	2.731	2.565	
Skew.	0.699	0.658	0.658	0.701	0.702	0.701	0.682	
Excess Kurt.	0.316	0.121	0.012	−0.081	−0.226	−0.290	−0.302	
ADF	−1.528	−1.389	−1.538	−1.344	−1.198	−1.131	−1.117	
	y_4	y_8	y_{12}	y_{20}	y_{28}	y_{40}	y_{60}	
The UK Yield (subscript is the number of months to maturity)								
Mean	8.140	8.197	8.249	8.334	8.391	8.384	8.169	
Std.	3.213	3.081	3.027	3.013	3.042	3.054	2.925	
Skew.	0.319	0.263	0.247	0.217	0.195	0.195	0.221	
Excess Kurt.	−1.131	−1.066	−0.986	−0.972	−1.014	−1.001	−0.864	
ADF	−1.454	−1.454	−1.474	−1.42	−1.299	−1.146	−1.078	

Note:

1. The data are annualized percentage rates.
2. 5% significance level for ADF test is −2.89; the lag in the ADF test is determined by AIC.
3. Output gaps are from OECD website; CPI/RPIX inflation and 3 month Treasury bill rates are from Datastream. Yields are discount bond equivalent data compiled by the New York Fed and Bank of England. Mean denotes sample arithmetic mean expressed as percentage p.a.; Std. standard deviation and Skew. and Excess Kurt. are standard measures of skewness (third moment) and excess kurtosis (fourth moment). ADF is the Adjusted Dickey–Fuller statistic for the null of non-stationarity. The 5% significance level is (−)2.877.

The paper is organized as follows: Section 2 specifies the macro-finance model; Section 3 describes the data and estimation method, and reports the specification tests and the results for the preferred model (M1); and Section 4 provides a summary of the key findings and offers some concluding remarks.

2. The model framework

We base this specification on the central bank model, which represents the behavior of the macroeconomy in terms of the output gap, inflation and the short-term interest rate.[1] We follow Kozicki and Tinsley (2001) and Dewachter and Lyrio (2006) and add Kalman filters to allow for inflation asymptotes or stochastic trends.[2] This KVAR approach uses a closed economy model developed originally for the US; we adapt it by allowing for international influences.

2.1. The macro models

Our macro system includes eight observable macro variables: the aggregate OECD output gap g^{**}_t and inflation π^{**}_t; the US output gap g^*_t, inflation π^*_t and interest rate r^*_t; and the UK output gap g_t, inflation π_t and interest rate r_t. OECD variables represent the world economy and are denoted by (**)-superscripts. US variables are denoted by (*)-superscripts and UK 'home country' variables are unsubscripted.[3] We start by estimating two separate closed economy macro-only KVARs, one for the 'world' (modeling $g^{**}_t, \pi^{**}_t, g^*_t, \pi^*_t$ and r^*_t) and one for the UK (modeling g_t, π_t and r_t). Preliminary analysis (see Table 1) suggests that inflation, interest rates and yields are all non-stationary. Theoretically, interest rates and yields should be cointegrated in this case (Beechey et al., 2009). We find that there is a non-stationary common trend driving OECD and US inflation rates with the cointegrating vector $[1, -1]$, meaning that the OECD and US inflation asymptotes move on a one-for-one basis.[4] This suggests the use of a single stochastic trend to represent this inflation trend in the world model: f^*_t. We augmented this with a stationary latent variable (z^*_t) that represents the effect of a factor which affects the real interest rate temporarily. Similarly, work on a standalone macro-finance model for the UK suggests the use of two UK-specific factors: f_t is an $I(1)$ stochastic trend representing the non-stationary trend in the nominal variables and z_t is a stationary $I(0)$ variable representing real interest effects.

2.2. The OECD–US macro KVAR

We use a KVAR(N^*) process to describe the joint OECD–US or 'world' macroeconomic dynamics under the real world or state density probability measure $\mathscr{P}$, where N^* is the order of the lag length. The BIC test results (reported in Liu and Spencer, 2009) indicated that a first-order difference system was appropriate in this case ($N^* = 1$). This gives a relatively compact world macro model:

$$\mathbf{x}^*_t = \boldsymbol{\kappa}^* + \boldsymbol{\phi}^*_z z^*_t + \boldsymbol{\phi}^*_f f^*_t + \boldsymbol{\Phi}^*_1 \mathbf{x}^*_{t-1} + \mathbf{w}^*_t,$$
$$\mathbf{w}^*_t = \mathbf{G}^* \mathbf{D}^{x*} \epsilon^{x*}_t, \quad \epsilon^{x*}_t \sim N(\mathbf{0}, \mathbf{I}), \tag{1}$$

where $\mathbf{x}^*_t = [g^{**}_t, g^*_t, \pi^{**}_t, \pi^*_t, r^*_t]'$ is the observed world macro vector and $\mathbf{w}^*_t$ is a 5×1 error vector; $\mathbf{D}^{x*}$ is a 5 by 5 diagonal matrix with positive diagonal elements; $\mathbf{G}^*$ is a 5×5 lower triangular matrix with unit diagonal. The real factor z^*_t and the nominal factor f^*_t processes are integrated of order zero ($I(0)$) and one ($I(1)$), respectively:

[1] Akram and Eitrheim (2008) evaluate the central bank model against VAR alternatives that include asset prices.

[2] These are also known as variable end-points, and are non-stationary latent variables (i.e. integrated of order one: $I(1)$). They are designed to capture common trends that cause the associated nominal variables to be cointegrated. This means that although these nominal variables are non-stationary, there is a linear relationship between them that is stationary.

[3] In the interests of simplicity we did not model the (average) OECD interest rate, relying instead upon the theory that in equilibrium this should be approximated by $(r^*_t + \pi^{**}_t - \pi^*_t)$.

[4] An ADF test on the differential $\pi^*_t - \pi^{**}_t$ gives the test statistic of −4.385, rejecting the null of a unit root.