Causes of the Financial Crisis: An Assessment using UK Data

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Causes of the Financial Crisis: an Assessment Using UK Data[1]

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Abstract:

We present empirical evidence that the marked rise in liquidity in 2001-2007 was due to large and persistent current account deficits and loose monetary policy. If this increase in liquidity was a pre-condition for the financial crisis that began in July 2007, we can conclude that loose monetary and the deterioration in current account balances were causes of the financial crisis.

Keywords: financial crisis, liquidity, monetary policy, global imbalances

JEL Classification: G01, E44, E52

[1] We thank Sir John Gieve for helpful comments.

1) Introduction

The global financial crisis that began in July 2007 looks set to run for some time and to have profound effects on the global economy. The magnitude of the event and the scale of the disruption caused has led to much speculation as to the deeper causes of the crisis.

Three main factors have been discussed. Loose monetary policy in the years before the crisis, especially in the US, has been suggested as a major cause. This view is particularly associated with John Taylor, who has argued (eg Taylor 2008, 2008a) that in 2001-2006 US interest rates were below those implied by a Taylor rule, by up to 2 percentage points (see also Calomiris, 2008). It is suggested that loose monetary policy fuelled the rapid rise in house prices in this period, led to fewer mortgage defaults and so led to the over-pricing of mortgage-backed securities (which assumed the unusually low default rates in the early 2000s were the norm).

Other commentators and policymakers (e.g. Caballero et al, 2008, Morris, 2008, Bean, 2008) have highlighted the importance of global imbalances. Large current account surpluses in emerging economies with under-developed financial markets, especially China, it is argued, led to large financial flows that drove down the interest rate in the US and other developed economies. Coupled with a decline in savings rates, especially in the US and UK, this led to a wave of financial innovation that created ever more complex products attempting to provide high returns while maintaining asset values. A third widely-identified factor is loose financial regulation (e.g. Borio, 2008). The very rapid growth in off-balance sheet risks and large investments in poorly-understood financial products, it is argued, created the pre-conditions for the rapid deterioration in financial markets that occurred in the summer of 2007 at the onset of the financial crisis.

In this paper, we provide a preliminary assessment of these ideas in the case of the UK economy. We focus on the amount of liquidity in financial markets. The rapid innovation in financial markets and the growth of arguably excessive risk-taking which led to the crisis would not have been possible without the build-up of liquidity in preceding years. Therefore the causes of this increase in liquidity can be seen as causes of the financial crisis[2]. We estimate the determinants of liquidity in the UK using time series data, examining in particular whether liquidity is affected by measures of global imbalances and the looseness of monetary policy. One weakness of our approach is that we cannot assess the contribution of regulation of financial markets since time series measures of the vigilance of financial regulation are not available. As a result, we cannot assess whether different regulatory actions would have been able to avert the crisis.

Various measures of liquidity have been used in the literature, reflecting bid-ask spreads (e.g. Kyle, 1985; Eckbo and Norli, 2002), the price impact of trades (Brennan and Subrahmanyam, 1996) and return reversal (Pastor and Stambaugh, 2003); Fujimoto (2004) provides a comprehensive review. In this paper we use the Bank of England index of liquidity, which combines these various aspects of liquidity into a single composite measure that reflects both national and global factors and reflects liquidity on financial markets in general, rather than specifically on the stock market (the focus of most other studies).

[2] Evidence that liquidity is a key indicator in predicting previous financial crises (Adalid and Detken, 2009) also suggests using liquidity as an indicator of the current crisis.

We estimate a series of models to explain this general measure of UK liquidity. Our baseline specification includes the current account deficit of the G7 economies, the savings rate in the UK, a measure of the looseness of monetary policy and a measure of default risk. We consider two types of measure of the looseness of monetary policy. Following Taylor (2008), we use deviations of interest rates from a Taylor rule to measure the difference between the interest rate and the rate warranted by values of inflation and the output gap. Another aspect of the looseness of monetary policy concerns the money supply. It has been argued that "excessive" growth in the money supply fuels liquidity. In the pre-crisis period, some commentators (e.g. Congdon, 2005) argued that policymakers were wrong to ignore rapid growth in the nominal supply (which averaged 9% p.a. in the UK in 2001-2006) because of their focus on stabilising inflation and output. The link between the growth rate in the money supply and liquidity has been refined by Adrian and Shin (2008) who argue that the relationship is likely to be close when banks seek to maintain a fixed leverage ratio. To test this idea, we use deviations of the real money supply from an estimated long-run money demand equation as a measure of "excess" money growth.

Estimates of our baseline specification reveal that the effects of G7 current account deficits are significant, have the expected sign and are robust to the inclusion of other controls as are the effects of the UK savings rate and the default spread. Measures of the looseness of UK monetary policy derived from Taylor rules were not significant, but excess money growth is significant and correctly-signed. The rise in liquidity in the pre-crisis period can therefore be explained in terms of high current account deficits, low savings rates, low default spreads and a rapid expansion of the money supply.

We then explore the national and global determinants of liquidity in greater detail. There is evidence that UK liquidity is affected by US monetary policy, as both Taylor's (2008) measure of the looseness of US monetary policy, and a measure based on residuals from a real money demand function, are correctly-signed and significant. However, neither performs as well as the UK excess money growth measure. Alternative specifications using the UK current account and the G7 savings rate were less successful than our baseline specification. In summary, liquidity in the UK reflects a mixture of national and global factors.

We also investigate more complex relationships between our explanatory variables. It has been suggested that global imbalances and looseness in monetary policy were both necessary pre-conditions for the crisis (Bean, 2008, Brunnermeir, 2009, and Morris, 2008). To capture this, we allow for a multiplicative effect from these variables. We also allow for the possibility that financial markets were more responsive to larger current account deficits and rates of monetary growth by including threshold effects that allow for stronger marginal effects when these variables exceed endogenously-determined thresholds. We find that both types of effect are significant.

We illustrate our estimates by calculating what liquidity would have been in the counterfactual case where the current account remained in balance and the real money supply was consistent with long-run growth in real money demand throughout our sample period. We find that there would have been no increase in liquidity in 2001-2007 period. The marked rise in liquidity in this period was therefore due to the effect of current account deficits and loose monetary policy. To the extent that a prior increase was a pre-condition for the financial crisis that began in July 2007, we can conclude that loose monetary and the deterioration in current account balances were causes of the financial crisis.

The remainder of the paper is structured as follows. Section 2) describes our data and the specification of our baseline empirical model. Section 3) presents estimates of this model. Section 4) presents estimates of extensions to our basic model to allow for interaction and threshold effects. Section 5) considers our counterfactual experiment. Section 6) concludes.

2) Methodology

Our baseline empirical specification is

(1) $$liq_t = \omega_0 + \omega_1 ca^{G7}{}_t + \omega_2 (s/y)_t + \omega_3 \mu^{ex}{}_t + \omega_4 \sigma^D{}_t + \varepsilon_t$$

where liq is the liquidity index for the UK produced by the Bank of England, ca^{G7} is the current account-GDP ratio of the G7 economies, (s/y) is the savings ratio in the UK, μ^{ex} is a measure of the looseness of UK monetary policy, and σ^D is the default spread (proxied by the spread between 10-year A or higher corporate bond and government bond yields). Previous empirical time series models (e.g. Chorida et al, 2001, Fujimoto, 2004) relate liquidity to default and term spreads; term spreads were not significant in our study and so are omitted from (1).

We use the index of liquidity for the UK calculated by the Bank of England. The index combines data on bid-ask spreads for Gilt Repos, the FTSE100 and major currencies, return-to-volume ratios for Gilts, the FTSE100 and equity options and liquidity premia, measured as the spread between corporate bonds and a credit spread and between bond and Libor rates in the US, Euro-zone and the UK (for further details, see Bank of England, 2007). It reflects a mixture of UK-specific and more global indicators. The index is depicted in figure 1a)[3], showing the continual rise over the five years before 2007 that has been seen as a pre-cursor of the crisis, followed by a precipitous decline from mid-2007 as the crisis hit. The effects of earlier crises at the end of the 1990s are also apparent. The current account of the G7 economies is depicted in figure 1b) for our sample period, 1992Q1 to 2008Q4[4], where we note a sharp secular decline beginning in 1998, followed by a persistent deficit of around 2%, giving a substantial and sustained global imbalance. The UK savings rate, depicted in figure 1c), shows a secular decline from the early 1990s, with an especially sharp decline in the 18 months before the crisis. The default spread, shown in figure 1d) was stable and low in the years before the crisis, before increasing sharply in recent periods.

We use several alternative measures of the looseness of monetary policy in the UK. First, we consider deviations from the Taylor rule

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[3] The series has been centred and normalised, so a value of 1 represents a 1-standard deviation difference from the mean.

[4] Current account data, G7 saving ratios and corporate yields are taken from Datastream. The remaining UK data are available from the Bank of England and the Office for National Statistics websites. All US data are taken from the Federal Reserve Bank of St. Louis website.

(2) $$i_t = \alpha_0 + \alpha_1(\pi_{t+j} - \pi^T) + \alpha_2(y - y^*)_{t+k} + \varepsilon_{it}$$

where i is the base rate set by the policymakers, π is the inflation rate, π^T is the inflation target and $(y - y^*)$ is the output gap. We use $\mu^{ex}{}_t = -\varepsilon_{it}$ as our measure of the looseness of monetary policy since a negative value of ε_{it} implies looser policy. We use the inflation rate targeted by monetary policy, namely the annual change in the RPIX price index until December 2003 and the annual change in the CPI thereafter. Correspondingly, the inflation target is 2.5% until December 2003 and 2% thereafter. The output gap is the proportional difference between GDP and its' Hodrick and Prescott (1997) trend. In our first measure, we follow Taylor (2008) in considering contemporaneous values of the inflation and output gaps (where $j = k = 0$) and imposing $\alpha_1 = 1.5$ and $\alpha_2 = 0.5$. In our second measure we allow for forward-looking behaviour by selecting the values of j and k that give the best empirical fit and estimate α_1 and α_2. Our third measure of the looseness of monetary policy focuses on growth in the real money supply in excess of equilibrium real money demand. We use estimates of the real money demand function.

(3) $$(m - p^c)_t = \beta_0 + \beta_1 y_t + \beta_2 (i^L - i)_t + \varepsilon_{mt}$$

where m is the log nominal money supply (we use a divisia index measure of M4; divisia index measures of the money supply have been argued to have a closer relationship to expenditure as it weights the components of the money supply in proportion to their usefulness in making transactions, see Hancock, 2005, and Darrat et al 2005), p^c is the consumer price index (measured using the RPI index) and i^L is the long term interest rate (measured using the 10-year government bond yield). This specification echoes Coehen and Vegas (2001) and Milas (2009). We use $\mu^{ex}{}_t = \varepsilon_{mt}$ as a positive value of ε_{mt} implies looser policy.

These three measures of the looseness of UK monetary policy are depicted in Figure 2a)-2c). We note that the measures derived from a Taylor rule show little evidence of loose monetary policy in the pre-crisis period since policy rates are rarely more than 100 basis points away from their Taylor rule values. By contrast, the excess money supply measure indicates substantial looseness in the pre-crisis period of 2001-2007.

3) Empirical Estimates

Estimates of the baseline model in (1) are presented in columns (i)-(iii) of table 1). We treat all variables as endogenous and estimate by Instrumental Variables (IV) using lagged values as instruments. The specifications in columns (i) and (ii), which use Taylor rule residuals to measure the looseness of monetary policy, perform poorly in contrast to the specification in column (iii), which uses a measure based on money growth, as the fit of the model is worse and these specifications fail a test for parameter stability[5]. These estimates are robust, save for some fragility in the effect of the savings rate. For example, similar estimates are obtained if

[5] We experimented with specifications that allowed Taylor rule residuals to affect liquidity with a delay. The only negative and significant effects were found with a lag of six quarters or more; it is implausible that monetary policy would affect liquidity with such a long delay.

the OECD current account deficit replaces that of the G7, or if a non-divisia measure of the money supply is used.

We next explore the national and global determinants of liquidity in greater detail. We first consider the effects of US monetary policy on UK liquidity. Figure 2d) depicts the measure used by Taylor (2008), deviations from a Taylor rule with imposed coefficients. In contrast to the corresponding UK measure, there is evidence of substantial looseness in the pre-crisis period. Figure 2e) depicts the measure of "excess" monetary growth, which also shows considerable looseness in 2001-2007. Columns (iv) and (v) of table 1) report estimates of versions of (1) using these indicators. Both models perform well but neither is superior to the model in column (iii). Columns (i) and (ii) of Table 2) repeat the specification of column (iii) of table 1) but with the UK rather than the G7 current account (column (i)) and the G7 rather than UK savings rate (column (ii)). The UK current account is insignificant, while the G7 savings rate is significant; the fit of both models is again worse than column (iii) of table 1).

Adrian and Shin (2009) report that a liquidity-related variable, the growth in repo trades by US prime brokers, is negatively related to stock market volatility, suggesting an inverse relationship between liquidity and volatility (possibly because higher volatility implies greater risk). To allow for this, we augment the baseline specification with a measure of the volatility of interest rates:

(4) $$liq_t = \omega_0 + \omega_1 ca^{G7}{}_t + \omega_2 (s/y)_t + \omega_3 \mu^{ex}{}_t + \omega_4 \sigma^D{}_t + \omega_5 V^i{}_t + \varepsilon_t$$

where V^i is the volatility of the UK base rate (specifically the 8-quarter moving standard deviation of the base rate; this is reported in Figure 3) and where we use the “excess” money growth measure of the looseness of monetary policy in this and subsequent models. Estimates of this extended specification are presented in column (iii) of table 2). The effect of volatility is negative, and significant. Inclusion of the volatility measure highlights the fragility of estimates of the savings rate. Given this, we drop the savings rate from our model, giving a simplified specification, estimates of which are presented in column (iv). We also experimented with measures of the fiscal deficit and government debt as a proportion of GDP and of the volatility of output growth; none of these were significant.

4) Interaction and Threshold Effects

The models estimated thus far assume that explanatory variables have a linear effect on liquidity. Given the complexity of financial markets, it might be argued that this is overly-simple. For example, the impact of global imbalances and looseness in monetary policy might be multiplicative (consistent with arguments in e.g. Bean, 2008, Brunnermeir, 2009, and Morris, 2008, that both were necessary pre-conditions for the crisis). It might also be argued that financial markets were more responsive to exceptionally large current account deficits and monetary growth, suggesting a stronger effect from larger values of these imbalances.

To test these ideas, we estimate the augmented model

(5)

$$liq_t = \omega_0 + \omega_1 ca^{G7}{}_t + \omega_3 \mu^{ex}{}_t + \omega_4 \sigma^D{}_t + \omega_5 V^i{}_t + \omega_6 ca^{G7}{}_t * \mu^{ex}{}_t + \omega_7 \left|ca^{G7}{}_t\right|_{>\tau^{ca}} + \omega_8 \left|\mu^{ex}{}_t\right|_{>\tau^{\mu}} + \varepsilon_t$$

where $\left|ca^{G7}{}_t\right|_{>\tau^{ca}} = ca^{G7}{}_t$ if $\left|ca^{G7}{}_t\right| \geq \tau^{ca}$ and $\left|ca^{G7}{}_t\right|_{>\tau^{ca}} = 0$ if $\left|ca^{G7}{}_t\right| < \tau^{ca}$ and $\left|\mu^{ex}{}_t\right|_{>\tau^{\mu}} = \mu^{ex}{}_t$ if $\left|\mu^{ex}{}_t\right| \geq \tau^{\mu}$ and $\left|\mu^{ex}{}_t\right|_{>\tau^{\mu}} = 0$ if $\left|\mu^{ex}{}_t\right| < \tau^{\mu}$ and τ^{ca} and τ^{μ} are parameters to be estimated. In (5), the marginal impact of current account deficits on liquidity is $\omega_1 + \omega_6 \mu^{ex}{}_t + \omega_7 I_{ca^{G7} > \tau^{ca}}$, where $I_{ca^{G7} > \tau^{ca}}$ is an indicator function taking the value of 1 if the current account exceeds τ^{ca}, and 0 otherwise. The parameter ω_6 captures multiplicative effects. The parameter ω_7 allows the impact of current account deficits to vary depending on whether the deficit exceeds τ^{ca} %; if $\omega_7 < 0$, then liquidity is more sensitive to larger current account deficits. Similarly, the marginal impact of monetary policy looseness is $\omega_3 \mu^{ex}{}_t + \omega_6 ca^{G7}{}_t + \omega_8 I_{\mu^{ex}{}_t > \tau^{\mu}}$ which depends on both imbalance measures, where ω_6 again captures multiplicative effects and ω_8 allows the impact of monetary policy looseness to depend on the size of the variable.

Estimates of this model are presented in column (v) of table 2)[6]. The standard error is substantially lower than any previous model. The estimate of ω_6 is significant, indicating an interaction effect. We estimate τ^{ca} =1.8%; and find that current account deficits which exceed this threshold have a marginal impact about 70% larger. G7 current account deficits exceeded 1.8% in 2005-2007, so a combination of substantial deficits and an increased

[6] Chan (1993) shows how to obtain a super-consistent estimate of the thresholds; we choose the combination of $\mu^{ex}{}_t$ and $ca^{G7}{}_t$ values that delivers the lowest residual sum of squares for the estimated regression.

marginal effect imparted a strong impact on liquidity in the immediate pre-crisis period. The estimate of ω_8 is significant but the estimate of ω_3 is not, showing that liquidity is only affected by loose monetary policy once this exceeds 2.1%, our estimate of τ^{μ}. This threshold was breached in 2001-2007, indicating that loose monetary policy also contributed to the rise in liquidity in the pre-crisis period.

5) Assessment and counterfactuals

In this section we quantify the impact of current account deficits and loose monetary policy. We calculate the time path liquidity would have taken in the counterfactual case where the current account was in balance and the real money supply was consistent with long-run growth in real money demand. We calculate this as

6) $$l\hat{i}q_t = \hat{\omega}_0 + \hat{\omega}_4 \sigma^D{}_t + \hat{\omega}_5 V^i{}_t$$

where $l\hat{i}q$ is the counterfactual value of liquidity, and $\hat{\omega}_0$, $\hat{\omega}_4$ and $\hat{\omega}_5$ are estimated parameters.

We plot actual and counterfactual values of liquidity in figure 4), where we use estimates of our preferred model in column (v) of table 2). The two series are similar, save for the 2001-2007 period. There is no growth in liquidity in this period in the counterfactual case. Therefore the marked rise in liquidity in this period was due to the effect of current account deficits and loose monetary policy.

6) Conclusions

This paper has presented an empirical model of the macroeconomic determinants of liquidity that focuses on the effects of global imbalances and monetary policy. We argue that the increase in liquidity in 2001-2007 was due to large and persistent current account deficits and to loose monetary policy in this period. These factors can therefore be seen to some extent as causes of the major financial crisis that began in July 2007.

Our results suggest that the exclusive focus of monetary policymakers on stabilising inflation and output may have in part contributed to the creation of the pre-conditions for the financial crisis. Arguably, a policy response to the increasing build up of liquidity might have prevented or at least lessened the crisis. Of course, it is difficult to assess whether the build up of liquidity is “excessive” in real time and trends that are clear in retrospect may not be obvious at the time. Nonetheless, recent experience suggests that some sort of pre-emptive response to similar situations in future may be warranted.

Our study is not definitive. We use a national measure of liquidity specific to the UK, consider a relatively limited set of explanatory variables and have little data from the crisis period. A more comprehensive study that uses a global liquidity measure, or measures from more countries, that has a larger set of explanatory variables and which takes a longer time perspective with more data from the crisis period may reach more definitive conclusions. Nonetheless, we feel our study is interesting and suggestive. We intend to develop it in subsequent work.

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Figure 1: Liquidity, G7 current account-GDP ratio, savings ratio and default spread.

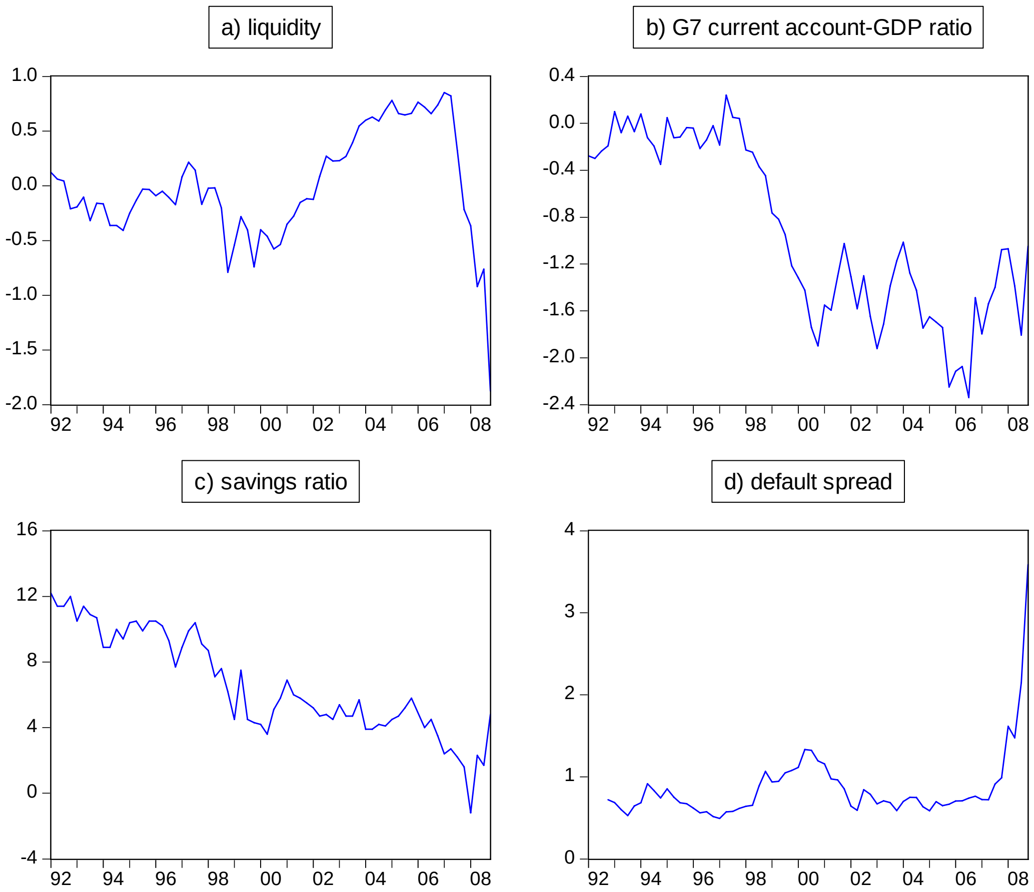

Figure 2: Measures of monetary looseness

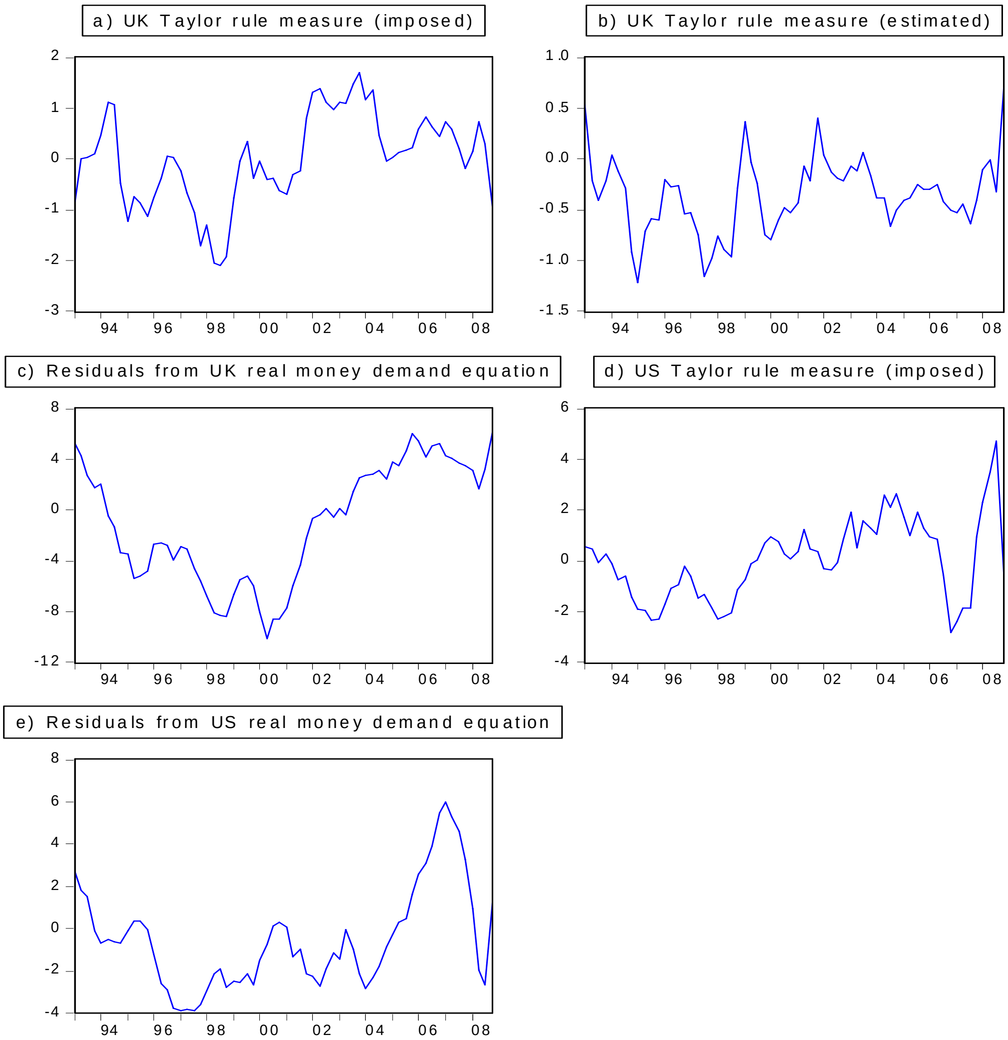

Figure 3: Volatility of the UK base rate

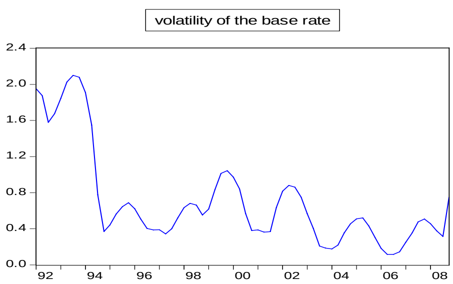

Figure 4: Actual and counterfactual values of liquidity

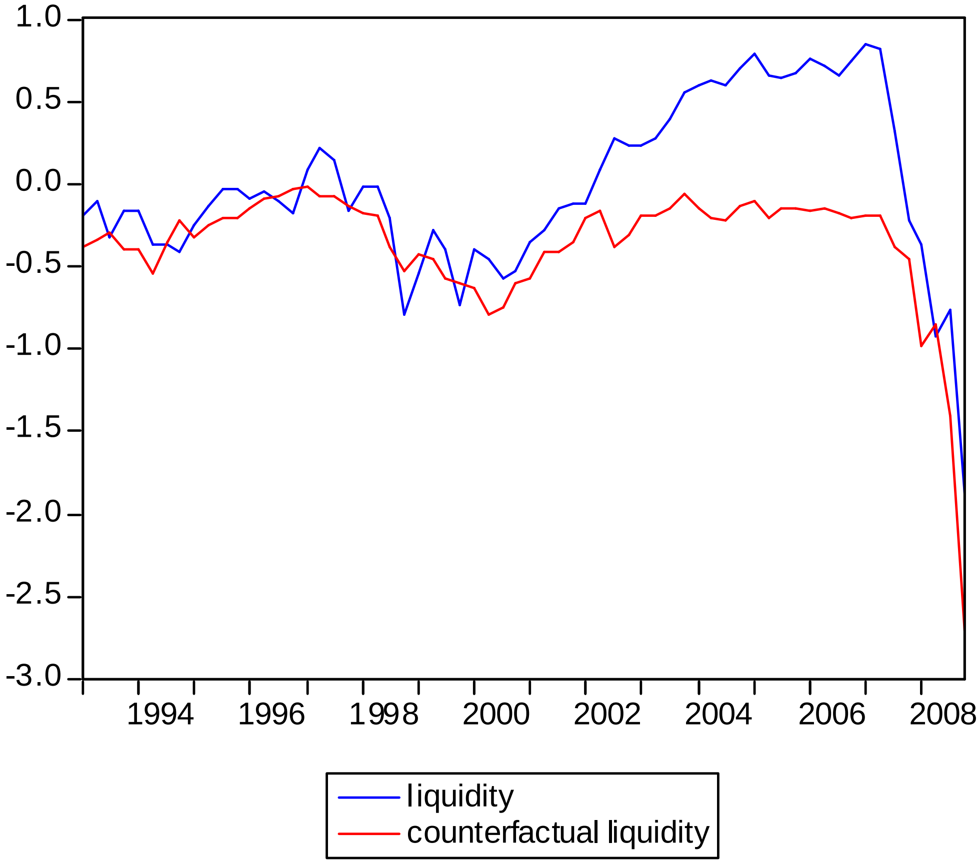

Table 1): IV Estimates of liquidity equation, 1992Q1-2008Q4

$$liq_t = \omega_0 + \omega_1 ca^{G7}{}_t + \omega_2 (s/y)_t + \omega_3 \mu^{ex}{}_t + \omega_4 \sigma^D{}_t + \varepsilon_t$$

	(i)	**(ii)**	**(iii)**	**(iv)**	**(v)**
Monetary policy measure	**UK Taylor rule* (imposed)**	**UK Taylor rule** (estimated)**	**UK Money supply*****	**US Taylor rule* (imposed)**	**US Money supply******
ω_0	1.040 (0.253)	1.039 (0.254)	0.891 (0.159)	1.678 (0.183)	1.445 (0.344)
ω_1	-0.247 (0.076)	-0.251 (0.085)	-0.195 (0.034)	-0.251 (0.059)	-0.183 (0.050)
ω_2	-0.041 (0.018)	-0.047 (0.020)	-0.027 (0.013)	-0.094 (0.015)	-0.049 (0.034)
ω_3	0.045 (0.046)	-0.129 (0.080)	0.038 (0.006)	0.083 (0.034)	0.036 (0.007)
ω_4	-1.192 (0.164)	-1.187 (0.160)	-1.001 (0.075)	-1.245 (0.117)	-1.058 (0.105)
Regression standard error	0.302	0.303	0.228	0.280	0.278
$\bar{R}^2$	0.661	0.658	0.807	0.680	0.753
AR(4) (p-value)	0.01	0.01	0.02	0.03	0.04
Het (p-value)	0.84	0.82	0.85	0.84	0.81
Parameter stability (p-value)	0.00	0.00	0.08	0.04	0.05

Notes: Standard errors are reported in parentheses. Parameter stability is an F test of parameter stability (see Lin and Teräsvirta, 1994, and Eitrheim and Teräsvirta, 1996). The instruments are a constant and four lags of the base rate, liquidity, the current account, the savings rate, the default spread, the monetary looseness and the volatility measure. AR(4) is the Breusch-Godfrey 4rth order serial correlation F-test. Het is the Breusch-Pagan-Godfrey F-test for heteroskedasticity.

* Taylor rule is given by $i_t = \alpha_0 + \alpha_1(\pi_{t+j} - \pi^T) + \alpha_2(y - y^*)_{t+k} + \varepsilon_{it}$, where where $j = k = 0$ and we have imposed $\alpha_1 = 1.5$ and $\alpha_2 = 0.5$.

** Taylor rule is given by:
$i_t = (1-a_3)\alpha_0 + (1-a_3)\alpha_1(\pi_{t+j} - \pi^T) + (1-a_3)\alpha_2(y - y^*)_{t+k} + a_3 i_{t-1} + \varepsilon_{it}$, where $j = 8,\ k = 0$, α_0 is estimated at 4.12 (standard error=0.40), α_1 is estimated at 3.88 (standard error=1.34), α_2 is estimated at 2.50 (standard error=0.89) and we have allowed for interest rate smoothing. We have used the 8-quarter ahead inflation forecast provided by the Bank of England Quarterly Inflation Report (available from www. bankofengland.co.uk).

*** UK Money supply residuals from: $(m - p^c)_t = \beta_0 + \beta_1 y_t + \beta_2 (i^L - i)_t + \varepsilon_{mt}$. We estimate β_0=-15.71 (standard error=0.361), β_1=1.38 (standard error=0.029) and β_2=-0.01 (standard error=0.002).

**** US Money supply residuals from: $(m - p^c)_t = \beta_0 + \beta_1 y_t + \beta_2 i_t + \varepsilon_{mt}$, where m is the M2 stock of money, p^c is the consumer price index, y_t is GDP and i_t is the federal funds rate. We estimate β_0=-5.02 (standard error=0.243), β_1=0.92 (standard error=0.026) and β_2=-0.02 (standard error=0.001).

Table 2): Further IV Estimates of liquidity equation, 1992Q1-2008Q4

$$liq_t = \omega_0 + \omega_1 ca^{G7}{}_t + \omega_2 (s/y)_t + \omega_3 \mu^{ex}{}_t + \omega_4 \sigma^D{}_t + \omega_5 V^i{}_t + \omega_6 ca^{G7}{}_t * \mu^{ex}{}_t + \omega_7 \left| ca^{G7}{}_t \right|_{>\tau^{ca}}$$
$$+\omega_8 \left| \mu^{ex}{}_t \right|_{>\tau^{\mu}} + \varepsilon_t$$

	(i)	**(ii)**	**(iii)**	**(iv)**	**(v)**
Monetary policy measure	**UK Money supply*****	**UK Money supply*****	**UK Money supply*****	**UK Money supply*****	**UK Money supply*****
ω_0	1.290 (0.150)	1.655 (0.269)	1.098 (0.142)	0.886 (0.077)	0.470 (0.126)
ω_1	-0.021 (0.028)	-0.105 (0.047)	-0.122 (0.035)	-0.157 (0.034)	-0.279 (0.050)
ω_2	-0.061 (0.012)	-0.095 (0.024)	-0.020 (0.011)		
ω_3	0.041 (0.009)	0.032 (0.005)	0.041 (0.005)	0.044 (0.005)	0.020 (0.011)
ω_4	-1.023 (0.084)	-0.956 (0.065)	-1.020 (0.081)	-0.947 (0.058)	-0.854 (0.053)
ω_5			-0.273 (0.046)	-0.300 (0.044)	-0.149 (0.074)
ω_6					-0.021 (0.009)
ω_7					-0.193 (0.092)
ω_8					0.151 (0.064)
τ^{ca}					1.8
τ^{μ}					2.1
Regression standard error	0.250	0.232	0.208	0.200	0.180
$\bar{R}^2$	0.768	0.799	0.840	0.851	0.876
AR(4) (p-value)	0.04	0.10	0.12	0.16	0.17
Het (p-value)	0.80	0.82	0.82	0.83	0.84
Parameter stability (p-value)	0.05	0.10	0.10	0.12	0.15

Notes: Standard errors are reported in parentheses. Parameter stability is an F test of parameter stability (see Lin and Teräsvirta, 1994, and Eitrheim and Teräsvirta, 1996).

*** Money supply residuals from: $(m - p^c)_t = \beta_0 + \beta_1 y_t + \beta_2 (i^L - i)_t + \varepsilon_{mt}$. We estimate β_0 =-15.71 (standard error=0.361), β_1 =1.38 (standard error=0.029) and β_2 =-0.01 (standard error=0.002).