

Money Market Rates And Implied CCAPM Rates: Some International Evidence*

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Abstract

New Neoclassical Synthesis models equate the instrument of monetary policy to the implied CCAPM rate arising from an Euler equation. This paper identifies monetary policy shocks within six of the G7 countries and examines the movement of money market and implied CCAPM rates. The key result is that an increase in the nominal interest rate leads to a fall in the implied CCAPM rate. Incorporating habit still yields the same result. The findings suggest that the movement of these two rates implied by the transmission mechanism of monetary policy in NNS models cannot be reconciled through the consumption Euler equation.

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1 Introduction

The dominant paradigm in recent years within monetary economics has been the New Neoclassical Synthesis approach to monetary modeling. This approach has spawned a growing literature that examines the effect of monetary policy on key variables, such as real expenditure and inflation.¹ The focus of this paper concerns a key ingredient of these models, namely the consumption Euler equation. The Euler equation is the key link in the transmission mechanism of monetary policy within New Neoclassical Synthesis models (or NNS for short). It reflects the stance of monetary policy through the instrument of monetary policy - the nominal interest rate. NNS models assume that the central bank targets the nominal interest rate when setting monetary policy. Hence, a change in the nominal interest rate is transmitted through the Euler equation and has an impact on consumption, inflation and output.

Monetary models typically assume that the interest rate in the consumption Euler equation is a money market rate and they equate it to the monetary policy instrument for a central bank. This is problematic for monetary models given the evidence of the ‘risk-free rate puzzle’ found by Weil (1989). More recently, Canzoneri, Cumby and Diba (2002) find that the Federal Funds rate is negatively correlated with the implied CCAPM rate for the United States. An example of this can be seen in October 1979 for the US, where the Federal Reserve Board tightened monetary policy. The Federal Funds rate increased as a result of the monetary tightening, but the implied CCAPM rate moved in the opposite direction and fell. This observation poses a problem for NNS monetary models which equate the money market rate to the implied CCAPM rate and emphasize the transmission mechanism of monetary policy through the Euler equation. The implication of equating these two rates are that they should be perfectly correlated. Thus a problem exists in these models, if the direction of movement of the CCAPM rate implied by the transmission mechanism is different to the money market rate, being used as the instrument of monetary policy.

¹These New Neoclassical Synthesis models incorporate optimizing behaviour, rational expectations, and frictions that allow monetary policy to have real effects. Recent works include King and Wolman (1996), Rotemberg & Woodford (1997, 1999), Clarida, Gali & Gertler (2000), Erceg, Henderson and Levin (2000), Fuhrer (2000) and Goodfriend and King (1997, 2001).

This paper examines the transmission mechanism of monetary policy within NNS models in terms of their implications for movements of money market and implied CCAPM rates. In doing so, I determine whether the problem highlighted by Canzoneri, Cumby and Diba (henceforth CCD, 2002) is an isolated artifact of the US, or if a more significant problem exists. This is done by looking at data from six of the G7 countries. Implied CCAPM rates are constructed for all the countries under three scenarios. The benchmark case consists of a model with power utility. The other two cases introduce habit into the utility specification. I compute correlations between money market and implied CCAPM rates and examine their relative movements during times of monetary policy shocks. Historical events are examined over the last thirty years in the same spirit as the narrative approach utilised by Romer and Romer (1989, 2002) to try and identify policy periods, where monetary policy shocks led to central bank monetary policy actions that changed money market rates. The correlations between the real money market and implied real CCAPM rates are mostly low and often negative. In addition, they appear to move in opposite directions in the majority of the policy periods.

The paper tries to determine the extent and direction in which the real interest and implied real CCAPM rates moved in response to an exogenous monetary policy shock. Here, I adopt the Christiano, Eichenbaum & Evans (1999) approach to identifying and analysing the effects of an exogenous monetary policy shock on key variables, by examining impulse response functions from vector autoregressions to try and resolve the puzzle. The results show that all countries exhibit ‘hump-shaped’ responses for consumption and output, which arise from a money market rate shock. The implication of these impulse responses are that movements in money market rates are inconsistent with those of the implied CCAPM rate arising from the Euler equation. In particular, the implied response of the CCAPM rate to an increase in the money market rate is negative and the implication is that movements in the two rates cannot be reconciled through the consumption Euler equation.

The structure of the paper is as follows. Section 2 calculates and compares movements in the CCAPM rates, implied by the Euler equation, with associated money market rates. Section 3

adopts a narrative approach to identifying monetary policy shocks, and accounts for movements in money market and implied CCAPM rates during monetary policy periods. Section 4 implements the Christiano, Eichenbaum & Evans (1999) identification methodology and traces out the dynamic responses of consumption, inflation and output. These are then used to try and explain movements in the money market and implied CCAPM rates. Finally, section 5 concludes.

2 Comparison of Money Market And Implied CCAPM Rates

This section focuses on the methodology used to construct the implied CCAPM rates and compare their movements to the movements of money market rates. Implied CCAPM rates are constructed under three different scenarios. In the baseline case, consumers have period power utility functions and maximise expected lifetime utility. The other two cases considered are ones that incorporate habit into the utility specification. The reason for analysing models of habit is twofold. First, the problem lies within the demand side of NNS models, since the transmission mechanism of monetary policy has a direct impact on the household's consumption-savings decision. A change in the nominal interest rate arising from a monetary policy action affects expected consumption growth, leading to demand side effects. Thus, the key to addressing the problem is to focus on the household's decision problem. It is here that movements in money market and implied CCAPM rates should be consistent, in order for the monetary policy transmission mechanism to have meaning. The supply side is not central to the problem and so, models which modify the supply side, by changing assumptions from sticky wages to sticky prices, or other innovations like time to build, etc, will not succeed in addressing the issue. One possible avenue to resolve the problem is to modify household's preferences. Incorporating habit persistence does exactly this.

Second, the results under habit, provide a comparison to those in the baseline power utility case. They will hopefully shed some light on the robustness of the results in the baseline case, to different specifications for utility that incorporate features we would wish to see in monetary models.² The

²The literature on asset pricing has had some success in addressing both Mehra and Prescott's (1985) equity premium and Weil's (1989) risk free rate puzzles by incorporating habit persistence, e.g. Abel (1999) and Campbell & Cochrane (1999). The monetary literature has followed this success using habit to match the persistent responses of real expenditures and inflation, from a monetary policy shock, to data (Fuhrer, 2000). Also, Edge (2000) generates a liquidity effect by incorporating habit.

methodology and results in the power utility version is outlined next. It is followed by outlining Abel's (1999) model of habit together with its results.

2.1 The Baseline Power Utility Case

Consider a basic framework where a representative agent maximises expected lifetime utility:

$$\max U_t = \sum_{j=t}^{\infty} \beta^{j-t} E_t u(C_j) = \sum_{j=t}^{\infty} \beta^{j-t} E_t \left(\frac{C_j^{1-\theta}}{1-\theta} \right) \quad (1)$$

Here, period utility is a power utility function where θ denotes the coefficient of relative risk aversion. Consumers allocate income between consumption and holding two one-period bonds. The first bond is nominally riskless and pays out one dollar. The other pays out one unit of the consumption good. The first order necessary conditions for optimisation imply that:

$$\frac{1}{1+i_t} = \beta E_t \left[\left(\frac{C_t}{C_{t+1}} \right)^\theta \frac{P_t}{P_{t+1}} \right] \equiv \frac{1}{1+i_t^*} \quad (2)$$

This is the Euler equation which prices the nominally riskless bond. Here i_t denotes the nominal interest rate, i_t^* denotes the implied CCAPM rate and P_t is the price of one unit of consumption good. The first order necessary condition for the real riskless bond implies:

$$\frac{1}{1+r_t} = \beta E_t \left[\left(\frac{C_t}{C_{t+1}} \right)^\theta \right] \equiv \frac{1}{1+r_t^*} \quad (3)$$

r_t is the real interest rate and r_t^* is the implied real CCAPM rate. The right hand sides of equations (2) & (3) define the inverse implied nominal and real CCAPM rates. In order to construct these, the paper follows Fuhrer (2000) in assuming that the dynamics of consumption can be succinctly captured in a vector autoregression (VAR) written below in companion form:

$$Z_t = AZ_{t-1} + \varepsilon_t \quad (4)$$

where $Z_t = [c_t \ \pi_t \ y_t \ i_t \ m_t]'$. The variables in the VAR are log of real consumption, log of inflation (i.e. π_t is defined to be $\log(\frac{P_t}{P_{t-1}})$), log of real disposable income, the relevant money market rate and monetary aggregate for each of the countries. The lowercase letters represent natural logs of the

variables, with the exception of the interest rates. ε_t is assumed to be iid $N(0, \Omega)$. Assuming that consumption growth and inflation are jointly lognormal variables, the right hand side of equations (2) & (3) can be expanded as follows:

$$\frac{1}{1+i_t^*} = \exp\{\ln \beta - \theta(E_t c_{t+1} - c_t) - E_t \pi_{t+1} + \frac{\theta^2}{2} \text{Var}(c_{t+1}) + \frac{1}{2} \text{Var}(\pi_{t+1}) + \theta \text{Cov}(c_{t+1}, \pi_{t+1})\} \quad (5)$$

$$\frac{1}{1+r_t^*} = \exp\{\ln \beta - \theta(E_t c_{t+1} - c_t) + \frac{\theta^2}{2} \text{Var}(c_{t+1})\} \quad (6)$$

Assuming that $\theta = 2$ and $\beta = 0.993$, the first and second order moments in the above equations are conditional moments which can be obtained by first estimating the coefficient matrix, A , in the VAR. The expectation terms in equation (5) are simply generated by performing one period ahead projections:

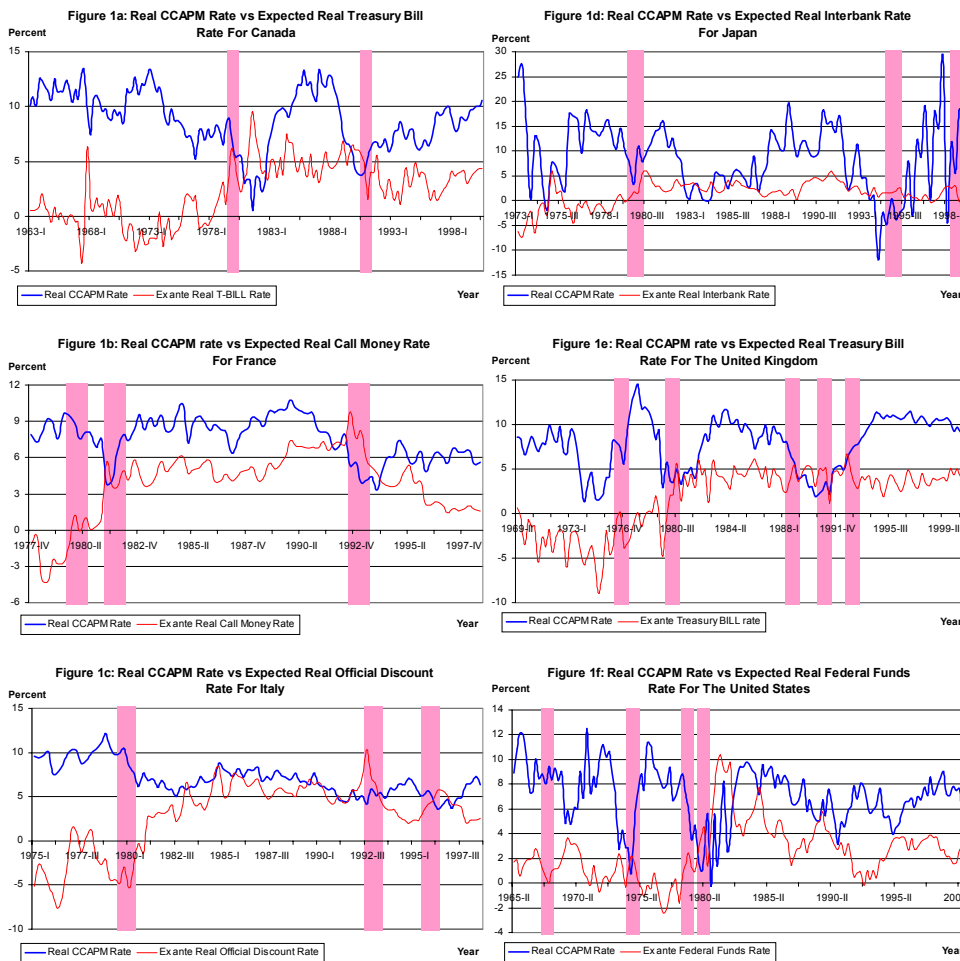
$$\begin{aligned} E_t c_{t+1} &= E_t e'_1 Z_{t+1} = e'_1 A Z_t \\ E_t \pi_{t+1} &= E_t e'_2 Z_{t+1} = e'_2 A Z_t \end{aligned}$$

where $e'_1 = [1 \ 0 \ 0 \ 0 \ 0]'$ and $e'_2 = [0 \ 1 \ 0 \ 0 \ 0]'$ are the selection vectors which pick out the first and second element in Z_{t+1} . Similarly, the variance and covariance terms in equation (5) are simply obtained from the variance-covariance matrix:

$$\begin{aligned} \text{Var}_t(c_{t+1}) &= e'_1 \Omega e_1 \\ \text{Var}_t(\pi_{t+1}) &= e'_2 \Omega e_2 \\ \text{Cov}_t(c_{t+1}, \pi_{t+1}) &= e'_1 \Omega e_2 \end{aligned}$$

Thus equations (5) & (6) are then used to construct the implied nominal and real CCAPM rates, i_t^* and r_t^* and these are plotted against the respective money market rates. The plots of the ex ante real money market, calculated using the VAR forecast of inflation, and implied real CCAPM rates

Figure 1: Comparison Of Ex-ante Real Money Market And Implied Real CCAPM Rates Across Countries.



can be seen in figure (1). The graphs of the nominal rates convey much the same information, and are not reported here.

The plots reveal two important results. First, the implied CCAPM rates are on average, larger than their respective money market rates and so a spread exists between the two. This is not unexpected, given past work by Weil (1989) and others who showed the inability of the Euler equation to reflect aggregate time series data. This can be seen further in Table 1 which compares the means of these series. The means of the implied CCAPM rate are different from the money market rate for both the nominal and real rates in every country. The existence of this spread between the implied real CCAPM rate and the real money market rate is one problem for monetary models which equate

Table 1: Means and Standard Deviations Of the Implied CCAPM and Money Market Rates

	No. of Obs	Nominal			Ex ante Real		
		CCAPM Rate	Money Market Rate	Correlation	CCAPM Rate	Money Market Rate	Correlation
Canada	155	14.139 (3.054)	7.428 (3.450)	0.016	8.854 (2.654)	2.257 (2.680)	-0.448
France	84	12.858 (4.587)	8.994 (3.517)	0.684	7.584 (1.749)	3.823 (2.850)	0.018
Italy	96	16.581 (6.262)	12.102 (3.746)	0.469	7.060 (1.854)	2.751 (4.157)	-0.609
Japan	105	12.629 (9.127)	5.387 (3.213)	0.411	8.533 (7.194)	1.415 (2.550)	-0.257
UK	127	15.282 (3.465)	9.079 (3.035)	0.228	7.869 (2.968)	1.804 (3.512)	0.242
US	169	11.375 (2.431)	6.511 (3.175)	0.202	7.221 (2.265)	2.423 (2.162)	-0.302

Table 2: Means and Standard Deviations Of the Implied CCAPM and Money Market Rates With Habit

Panel A: iid Consumption Growth						
	No. of Obs	Real CCAPM Rate		Real Money Market Rate		Correlation
		Mean	SD	Mean	SD	
Canada	154	2.241	4.063	2.232	4.003	0.303
France	115	2.651	4.011	2.595	3.893	0.088
Italy	114	1.731	5.780	1.380	5.689	0.541
Japan	104	1.320	4.126	1.384	4.112	0.050
UK	174	1.767	4.415	1.753	4.363	-0.020
US	168	2.495	2.490	2.405	2.434	0.202

Panel B: Conditional Lognormal Consumption Growth							
	No. of Obs	Mean Nominal		Correlation	Mean Real		Correlation
		CCAPM Rate	Money Market Rate		CCAPM Rate	Money Market Rate	
Canada	152	9.182 (5.991)	7.530 (3.448)	-0.345	2.263 (4.695)	2.273 (4.063)	0.037
France	82	9.504 (5.689)	8.942 (3.646)	0.272	2.021 (4.965)	4.082 (3.209)	-0.055
Italy	93	17.087 (3.995)	12.280 (3.659)	0.159	2.460 (5.277)	3.197 (3.920)	0.351
Japan	103	6.796 (12.047)	5.382 (3.250)	0.100	1.530 (10.332)	1.562 (3.912)	-0.033
UK	125	10.869 (6.640)	9.089 (3.045)	-0.528	2.031 (5.237)	1.761 (4.987)	0.128
US	165	7.591 (6.363)	7.154 (3.076)	-0.216	2.189 (2.189)	2.513 (2.631)	-0.192

the two. Examining the graphs in figure (1) reveals that these two rates do not always moving in the same direction. There are periods where they do move together, but there are also periods when they move in divergent directions. This is best highlighted by looking at the plots for France and Italy in figures 1(b) & (c). In both countries, the implied real CCAPM rate starts out high and

positive, whilst the real money market rate is negative. Over time, they get closer together, around the mid 1980's. Then, towards the end of their sample, they start to move in opposite directions, just after the ERM crisis in the early 1990's. Also, there are periods when the real money market rate moves very little, but the implied real CCAPM rate is very volatile, as in the case for Japan after 1996. Overall, the results imply that the two rates move in divergent directions when looking at their entire sample.

The second result highlighted within the plots reveal a more serious problem, even after abstracting from the spread. Given the transmission mechanism of monetary policy within the NNS models, a movement in the money market rate should be reflected by a corresponding movement in the implied CCAPM rate in the same direction. That is, the money market and implied CCAPM rates should be perfectly correlated. The correlations between the money market and implied CCAPM rates are also reported in Table 1.

As can be seen, none of the correlations are close to one. The correlations between the nominal rates are small for most of the countries, the largest being 0.68 for France. Since the nominal CCAPM rate is assumed to reflect the stance of monetary policy within the NNS models, a low correlation is problematic for these models. Furthermore, when considering the real rates, the correlations are negative for four out of the six countries, even as much as -0.61 for Italy. These results shed some doubt on the validity of equating the money market rate to the implied CCAPM rate, particularly in this baseline case. Next, the paper proceeds by analysing the case where habit is introduced into the utility specification.

2.2 Incorporating Habit

This paper utilises Abel's (1999) habit specification for two reasons. First, the habit specification developed by Abel (1999) provides a tractable model to check if the movements in interest rates can be matched. Second, Abel develops an algorithm which can pick parameter values such that the approximate unconditional means and variances of the riskless rate can be calibrated to match the sample values in data. The calibration is useful here as it provides a method to eliminate the observed average spread between the implied CCAPM rate and the money market rate in the

baseline case. Having eliminated the average spread, it is then possible to check if the movements between the two rates can be reconciled.

Under Abel's specification, consumers maximise a utility function of the form:

$$U_t = E_t \left\{ \sum_{j=0}^{\infty} \left(\frac{1}{1+\delta} \right)^j \left(\frac{1}{1-\alpha} \right) \left(\frac{\tilde{C}_t}{v_t} \right)^{1-\alpha} \right\} \quad (7)$$

where α is the coefficient of relative risk aversion, $v_t = C_t^{\gamma_0} C_{t-1}^{\gamma_1} (G)^{\gamma_2}$, is the benchmark level of consumption, and δ is the rate of time preference. \tilde{C}_t is individual consumption, whereas C_t is aggregate consumption and G is the unconditional growth in the reference or benchmark level of consumption. Under this specification, in equilibrium, the growth rate of consumption of a representative individual equals the growth rate of aggregate consumption. Thus, the nominal interest rate given by the Euler equation can be written as:

$$\frac{1}{1+i_t^*} = \beta E_t \left[\left(\frac{C_{t+1}}{C_t} \right)^{-A} \left(\frac{C_t}{C_{t-1}} \right)^{\phi} \frac{P_t}{P_{t+1}} \right] \quad (8)$$

where $\beta = \frac{G^{\gamma_2(\alpha-1)}}{1+\delta}$, $A = \alpha - \gamma_0(\alpha - 1) > 0$ and $\phi = \gamma_1(\alpha - 1)$. Abel's (1999) methodology provides a means to match the unconditional means and variances of the riskless rate to their sample values. This is done by calibrating the parameters, ϕ, A, β, G above using sample moments. Unique values for the parameters are obtained by imposing three restrictions: $\gamma_0 = 0, \gamma_0 + \gamma_1 + \gamma_2 = 1$, and $G = 1 + \mu$, where μ is the mean growth rate of consumption. As before, in order to proceed further, an assumption needs to be made about the distribution of consumption growth in the Euler equation (8). Two cases are considered here. The first case examined follows Abel (1999), where he assumes the growth rate of consumption is iid lognormal (henceforth just referred to as the iid consumption growth case) when devising the calibration methodology used to match the unconditional moments to their sample counterparts. Under this assumption, taking a lognormal expansion and imposing the restrictions above yields the implied inverse real CCAPM rate under iid consumption growth, where c_t denotes the log of consumption:

$$\frac{1}{1+r_t^*} = \beta \exp\left\{ \phi(c_t - c_{t-1}) - \alpha E_t(c_{t+1} - c_t) + \frac{\alpha^2}{2} Var(c_{t+1} - c_t) \right\} \quad (9)$$

A second distribution is also considered under habit as the third scenario. This is because the dynamic interaction of consumption and inflation, and its impact on interest rates, merit some study. In this case, consumption growth and inflation are assumed to be jointly conditional lognormal variables (henceforth just referred to as the joint lognormal case). This assumption allows an implied nominal CCAPM rate to be derived as well as an implied real CCAPM rate.³ As above, taking a lognormal expansion of equation (8) and imposing the restrictions on the γ 's, we get:

$$\begin{aligned} \frac{1}{1+i_t^*} &= \beta \exp\{-\gamma_1(\alpha-1)c_{t-1} + (\alpha + \gamma_1(\alpha-1))c_t - \alpha E_t c_{t+1} - E_t \pi_{t+1} \\ &\quad + \frac{\alpha^2}{2} Var c_{t+1} + \frac{1}{2} Var \pi_{t+1} + \alpha Cov(c_{t+1}, \pi_{t+1})\} \end{aligned} \quad (10)$$

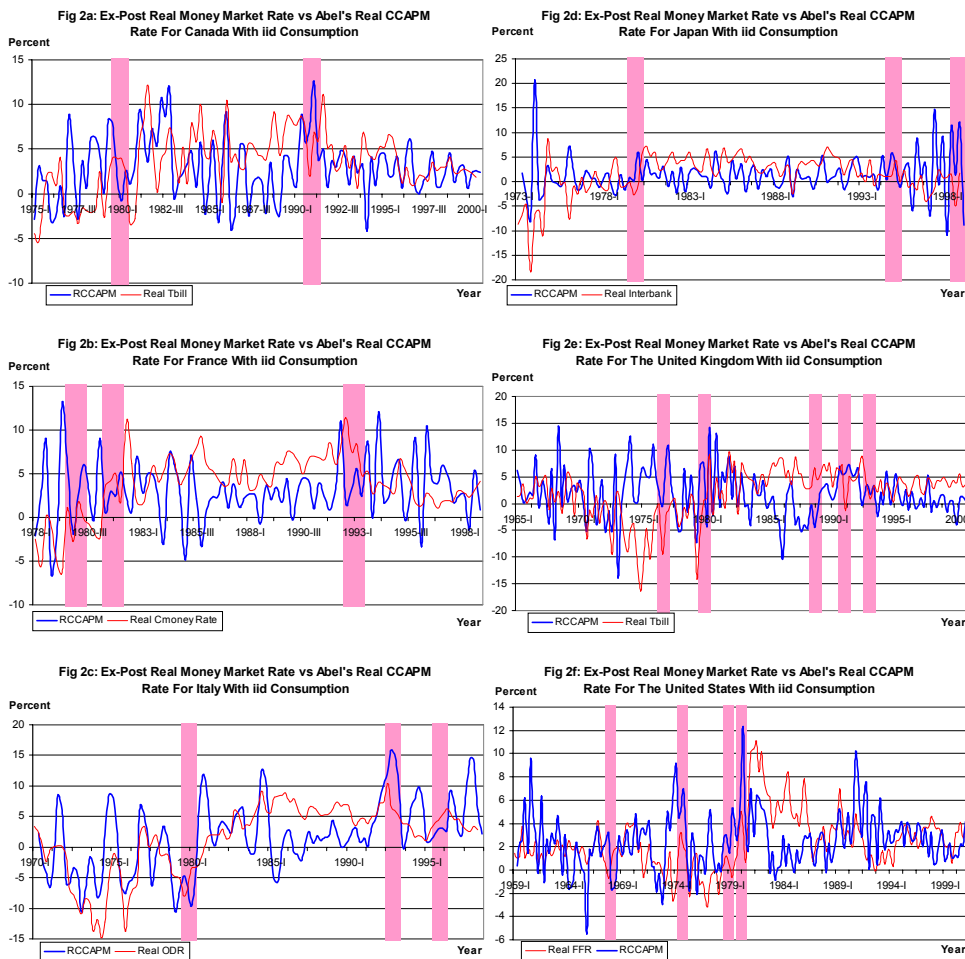
The implied real CCAPM rate under conditional lognormality has the same form as that given in equation (9), but will differ from the iid case.⁴ The statistics for the two rates under the two cases are reported in Table 2, and the results are depicted for iid and joint lognormal consumption growth in figures (2) and (3) respectively.

Considering first the case where consumption growth is counterfactually assumed to be iid lognormal. Table 2 shows that Abel's methodology manages to set both the mean and standard deviation of the implied real CCAPM rate, constructed from the parameters, very close to the mean and standard deviation of the actual ex-post real money market rate. These results are depicted in figure 2. The swings in the implied real CCAPM rate appear to be of the same order of magnitude as movements in the money market rates. The only exception is Japan, where there are large swings in the implied real CCAPM rate at the very beginning and end of the sample. Furthermore, the results here are relatively better than those in the baseline model: the correlations between the

³Strictly speaking, Abel's methodology calibrates parameters for the case where consumption growth is iid lognormal. It should be noted that the method to calibrate the parameters here will give biased parameter estimates under the assumption of joint lognormality. However, since the idea here is to generate a series whose unconditional mean and variance are "close" to those observed in the sample, we follow Abel's methodology as a starting point to generate such a series with those characteristics. The actual mean and variance of the generated series will then be used in the analysis and the results evaluated on that basis.

⁴The reason that these two implied real CCAPM rates will differ is because of the distributional assumptions made about the growth rate of consumption. In the case of iid consumption growth, the expectation and variance terms in equation (9) are simply the sample moments of the series. When consumption and inflation are jointly lognormally distributed, then the expectation is calculated as the one-step ahead projection from the VAR in equation (4).

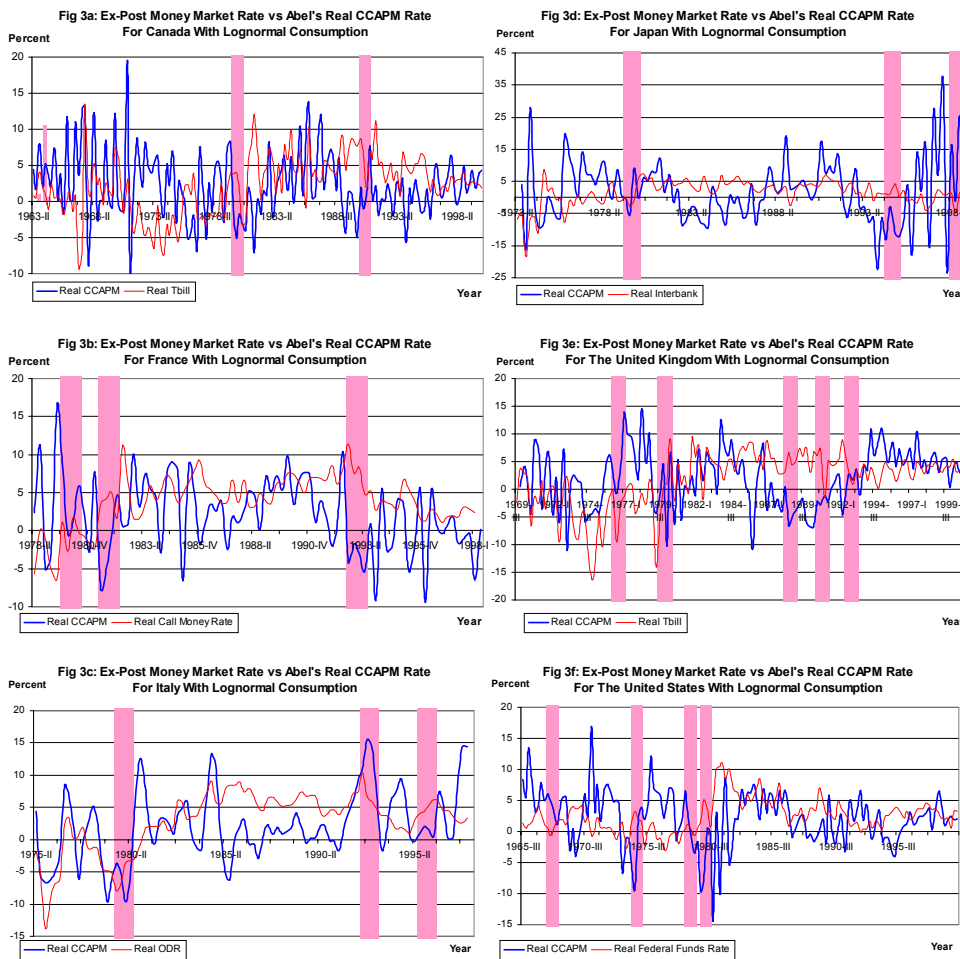
Figure 2: Comparison Of Real Money Market And Implied Real CCAPM Rates Across Countries Under Habit With iid Lognormal Consumption Growth.



implied real CCAPM rate and the ex-post real money market rate are all positive, with the exception of the United Kingdom. However, as before, the correlations are still not close to one. The largest is Italy with a value of 0.541.

The results for the second case where consumption growth and inflation are jointly conditionally lognormal shows that Abel’s methodology was once again successful in setting the mean of the implied series fairly close to the mean of the actual money market rates. These are reflected in Panel B of Table 2, where the mean of the nominal implied CCAPM rate is slightly larger than the corresponding mean of the nominal money market rate in every country. Looking at the real rates,

Figure 3: Comparison Of Real Money Market And Implied Real CCAPM Rates Across Countries Under Habit With Joint Lognormal Consumption Growth.



the mean of the implied real CCAPM rate is slightly below the corresponding real money market rate, with the exception of the United Kingdom. However, the cost of eliminating the average spread in this case, is slightly increased volatility in the implied real CCAPM rates.

The correlations for the nominal series are only negative for Canada, the UK and the US, with the other correlations being fairly low. The correlations between the implied real CCAPM rate and the ex-post real money market rate are negative for France, Japan and the US. However, they are still very low in Canada, Italy and the UK. With the exception of the UK, the correlations are all lower in this case when comparing them to the results from the iid consumption growth case. They are,

however, only slightly larger when comparing them to the results in the baseline case. Overall, the evidence here suggests that monetary models that equate the money market rate to the implied CCAPM rate still face a problem, even with the inclusion of habit persistence. This raises an issue for NNS models.

Since this problem concerns the transmission mechanism of monetary policy within these NNS models, the movements of the money market and implied CCAPM rates need to be examined around the time when the central bank implements monetary policy. The idea is to identify periods when central banks actively and visibly pursue monetary policy by changing interest rates. This is a key idea, since resultant movements in money market rates can then be identified and primarily attributed as the response of a monetary policy action. This next section identifies episodes of monetary policy actions by central banks.

3 Identifying Monetary Policy Responses

This section of the paper tries to identify monetary shocks using historical evidence. It does this in the same spirit as the narrative approach used by Romer & Romer (1989). However, a broader definition of monetary policy shocks is considered here, than that used by Romer & Romer (1989). In particular, they consider “*an attempt by the Federal Reserve to exert a contractionary influence on the economy in order to reduce inflation*” (Romer & Romer, 1989, pp 134) as a monetary shock. A broader definition is used here, not limited only to monetary contractions. In particular, the objective within this section is to identify periods of monetary policy actions by central banks, arising from monetary policy shocks.

In following this methodology, the paper attempts to identify periods where central banks were actively setting monetary policy, by changing interest rates, in pursuit of their objective, e.g. reduction of inflation in the late 1970’s, stabilising the exchange rate in the early 1990’s, etc. The intention here is twofold. First, the idea is to identify when the policy shock occurred.⁵ Having

⁵It should be noted that the episodes identified here are not just over specific single quarters, but instead over one year starting at the quarter in which it is identified. This timeframe allows us to analyse the effect of the policy on money market and implied CCAPM rates without having to identify the end of the period when the policy action was terminated.

done so, it is then possible to obtain a general idea for the movements in the money market and implied CCAPM rates during these monetary policy periods.

A multi country dataset, consisting of six of the G7 countries, is used here in the hope that a greater number of periods of monetary policy actions can be identified, rather than just considering historical evidence from only a single country such as the United States. The description of the data can be found in Appendix A and the sample periods for the countries being considered are summarised in Appendix A.5. Twenty periods of monetary policy episodes were found across all the countries and these are summarised in Appendix A.6. The evidence for these monetary policy actions are drawn from a variety of sources and are listed next. An analysis of movements in money market and implied CCAPM rates, within the identified periods, then follows.

Monetary Policy Episodes

Canada

Canada has two identifiable episodes where the Canadian central bank visibly implemented monetary policy. The first episode for Canada, and in most of the other industrialised countries, is from the third quarter of 1979 to the second quarter of 1980. Within this period, the Bank of Canada noted that (Bank of Canada, 1979, pp 3-12): *“There is no question but that interest rates as conventionally stated are very high. In terms of our history they are at record levels.”* (pg. 3). The statement continues later with:

“... it has now become clear ... that a substantial rise in interest rates was also needed in order to contain the rapidly expanding demand for money and credit in the domestic economy... it is my view that the actions taken by the Bank of Canada constitute a reasonable and prudent response to the potential inflationary damage that would be inflicted on the Canadian economy ...” (Bank of Canada, Nov 1979, pg. 9).

The statements above are indicative of the stance of monetary policy within Canada at that time. They suggest that the Bank of Canada was tightening monetary policy in order to combat inflationary pressures arising from the second OPEC oil shock. This is the basis for considering this as a monetary policy period arising from the OPEC oil shock for Canada.

The second episode occurs from the third quarter of 1990 to the second quarter of 1992. Again the Governor of the Bank of Canada notes that (Bank of Canada, 1990b): *“With strong demand pressures and a monetary policy committed to resisting inflation, there has been upward pressure on Canadian short-term interest rates.”* (pg 17). Furthermore, it was noted that:

“I want to emphasize that if the Bank of Canada had not progressively tightened monetary conditions in response to intensifying inflationary pressures, the inflation problem that we face today would have been greater still ... It is true that the Bank of Canada’s actions to limit the expansion of money and credit in our inflationary environment have been one factor pushing up short term interest rates ...” (Bank of Canada, 1990a, pg 12).

The statements above indicate that the Bank of Canada was tightening monetary policy, and this is the basis for considering this to be a monetary policy period.

France

France has three periods of monetary policy actions. The first was when the French central bank was seen to be visibly moving the money market rate from the third quarter of 1979 to the second quarter of 1980. As noted in the Economic Commentary found in the Bank of England’s (henceforth BOE) Quarterly Bulletin (1980):

“Despite the growing signs of recession, the reduction of inflation remains the prime policy target in virtually every industrial country. As inflation rose in 1979, there was a strong increase in interest rates in all the major overseas countries.” (BOE Quarterly Bulletin, 1980, Vol. 20, No.2, pg 134)

The industrial countries referred to in the Economic Commentary are Canada, West Germany, Japan, France, Italy, the UK and the US. The statement above along with the general outlook for the economies in the industrial countries found in the Commentary (pg 119-140), were that the central banks were attempting to combat the inflationary pressure arising from the second OPEC oil shock. Thus, this statement is taken as providing evidence that the French (and other industrialised) central bank was tightening monetary policy during this episode. For France, this was partly as a result of the inflationary pressure from the second oil shock, but also from participating in the

European Monetary System and joining the Exchange Rate Mechanism (ERM) (Goodhart, 1987, 1992).

The second episode of a monetary policy action taken by the Banque de France considered here is from the second quarter of 1981 to the first quarter of 1982. In May of 1981, François Mitterand pursued reforms leading to an inflationary environment in an episode which several commentators have come to call the “Mitterand Experiment”. This led the finance ministry to tighten monetary policy. As noted in the the BOE’s Quarterly Bulletin:

“In France, ... market expectations [were] that the Franc would be devalued following the change in policies heralded by the election of the new government... official intervention to support the Franc was substantial, despite sharp increases in domestic interest rates.” (BOE, Quarterly Bulletin, 1981, Vol. 21, No. 4, pg 481-482)

In picking the third monetary policy period, there appears to be evidence that the Banque de France was moving the nominal interest rate during the ERM crisis from the third quarter of 1992 to the second quarter of 1993 as they responded to a speculative attack occurring on the French Franc-Deutschmark exchange rate. Several commentators have noted this and some evidence is provided in the Bank of England’s Quarterly Bulletin:

“The French economy has experienced a period of prolonged exchange rate and interest turbulence. Market rates remained high throughout the autumn and early winter in defense of the franc’s parity within the ERM.” (BOE, Quarterly Bulletin, Vol 33, No. 1, pg 51)

Additional evidence can be found in Banque De France (1995), where they outline their intermediate objectives at that time:

“... [the] intermediate objectives are currently the exchange rate and the growth of a monetary aggregate... The August 1993 decision to broaden the fluctuation margins without changing the central [exchange] rates was taken to forstall speculation, but in no way modified the objective of maintaining the external value of the currency, which continues to be closely linked to the final objective of price stability.” (Banque De France, 1995, pg 12)

Italy

Italy has three identifiable episodes. Similarly to France, the first identified policy period arises partly from the second oil shock and also Italy's decision to participate in the ERM from the third quarter of 1979 to the second quarter of 1980 (see the quote from the BOE Quarterly Bulletin, 1980, above). The second identified period considered here arises from the ERM crisis which occurred during the third quarter of 1992 to the second quarter of 1993. During this time, the Italian central bank's attempted to defend the Lira-Deutschmark exchange rate during the speculative attack on its currency by raising short term interest rates. Evidence of the central bank's response to the shock can be found in a statement in the BOE Quarterly Bulletin (1992, Vol. 32, No. 4, pg 361). It stated that, *"Official interest rates were raised sharply in September in the defense of the lira."* As mentioned before, several commentators have noted this. One example is Eudey (1995), who noted that the British, French and Italian central banks raised interest rates in defense of their respective currencies:

"In an attempt to attract buyers to their currencies, the British, French and Italian governments offered very high rates of return on short-term instruments denominated in their home currencies." (Gwen Eudey, 1995, pg 318)

The final episode considered for Italy is from the third quarter of 1995 to the second quarter of 1996. The evidence supporting this shock, is taken from the BOE Quarterly Bulletin which noted that, *"In Italy, Spain and Sweden, the interest rate increase continues a period of monetary policy tightening started in the second half of last year."* (BOE Quarterly Bulletin, 1996, Vol 33, No. 3, pg 238-239). During this episode, the Italian government rejoined the ERM in Europe during the November of 1996.

Japan

Three episodes are considered for Japan. The first episode (as above for France and Italy) is from the second oil shock between the third quarter of 1979 to the second quarter of 1980. The second policy period considered here occurred from the third quarter of 1994 to the second quarter of

1995, when Japan was beginning to face deflationary pressure. The evidence is noted in the BOE Quarterly Bulletin:

“The Bank of Japan cuts its Official Discount Rate by 50 basis points on 8th September to a record low of 0.5%; Govenner Matsushita said the easing was to prevent further spread of deflation and to secure economic recovery. The Bank of Japan also reaffirmed its intention of guiding market rates below official rates.” (BOE Quarterly Bulletin, 1995, Vol. 35, No. 4, pg 337)

The statement here is indicative of relaxed stance for monetary policy as the Bank of Japan attempted to boost output growth through monetary expansion, and mitigate any deflationary pressures. Finally, the last occurrence is from 1998, as Japan tried to stimulate its economy by lowering the nominal interest rate to near zero:

“... overnight rate in Japan has remained close to zero, as a result of the confirmed ‘zero interest rate policy’ adopted by the Bank of Japan (BoJ) in February 1999... the BoJ ‘will flexibly provide ample funds and encourage the overnight call rate to move as low as possible’ in order to ‘assume permeation of the effects of monetary easing’.” (BOE Quarterly Bulletin, 2000, Vol. 40, No. 2, pg 144)

The last two actions included here are different from the types of policy actions considered by Romer & Romer (1989) in that they are monetary expansions. Romer & Romer (1989) only look for monetary contractions where the Federal Reserve actively moved to cut back aggregate demand because of excessive inflation. They do not attempt to identify monetary expansions because of the inherent difficulty in distinguishing the real effects of a monetary expansion, with the natural tendency of trend output to increase. In particular, the identification problem lies in an inability to separate an increase in output arising from trend output with an increase in output arising from an expansionary shift of monetary policy. That particular problem is not addressed within this paper. Moreover, examining monetary expansions are not so problematic here, as in the last two shocks proposed for Japan, simply because the idea here is to assess the stance of monetary policy and its implications for movements in money market and implied CCAPM rates.⁶ The documentary

⁶The idea within this paper, is to identify the stance of monetary policy and its implications for movements in money market and implied CCAPM rates, rather than focus on the liquidity effect of a monetary policy action on real variables. Central banks have access to contemporaneous information when deciding the stance of monetary policy. Thus any expectation terms used in the construction of the implied CCAPM rate are based upon the information set available to the central bank at the time. So the future values of variables like output do not matter, since the expectations are calculated as one step ahead projections using the current information set..

evidence is suggestive that the Bank of Japan was actively pursuing expansionary policy within this period.

United Kingdom

The UK has five identifiable episodes. The first episode identified is from the second quarter of 1976 till the first quarter of 1977. Just prior to the beginning of this episode, Sterling came under repeated pressure to depreciate. This led to a series of interest rate hikes between April to June of 1976 and a rescue package by the governors of the Group of Ten countries, Switzerland and the Bank for International Settlements which involved stand-by credit of over \$5 billion. As is noted in the Bank of England's Quarterly Bulletin (BOE Quarterly Bulletin, 1976, Vol. 16, No. 3), the Governor of the Bank of England declared in his annual speech: "*... the value of sterling had by then depreciated by over 16%, in spite of substantial intervention which was reflected in an underlying reserve fall of over \$3 billion.*" (pg 324). When looking at the operations of monetary policy within that time, it also notes that "*Conditions in the money market were generally kept very tight.*" (pg. 300).

The second identified episode was during the second oil shock as the the UK formally committed itself to monetarism under Prime Minister Margaret Thatcher in October 1979 and used monetary policy to fend off increasing inflationary pressures. In a speech given by the Govenor of the Bank of England in 1980, the Govenor said:

"A firm monetary policy has a central role in combating inflation, ...this task of promoting monetary stability can [not] always be accomplished without actions ... [that] are, harsh and disagreeable. I know that the present level of interest rates is bitter medicine... It is most hurtful to people committed to borrowing that they would not have undertaken had they known how high interest rates would rise." (BOE Quarterly Bulletin, 1980, Vol. 20, No1, pg 61)

The statement above indicates the tight stance of monetary policy at that time, which was being used to fight off inflationary expectations arising from the second oil crisis and reinforce the UK's commitment to monetarism. The period considered is from the fourth quarter of 1979 to the third quarter of 1980.

The third episode considered is from the second quarter of 1988 till the first quarter of 1989. Domestic interest rates were increased four times during June of 1988 as monetary policy was tightened because of accelerating money and credit aggregates which led to inflationary pressures. These hikes in interest rates continued in subsequent quarters. Documentary evidence is shown in the Quarterly Bulletin: “*Monetary conditions were tightened during the period [June-September 1988] in order to exert downward pressure on inflation and domestic demand growth.*” (BOE, Quarterly Bulletin, 1988, Vol. 28, No. 4, pg 485).

The fourth episode considered here is the period of monetary tightening from the third quarter of 1990 till the second quarter of 1991. This was just prior to the period when Iraqi forces had invaded Kuwait in early August of 1990, leading to expectations of the future Gulf War and increases in the price of oil. As is noted in the Quarterly Bulletin, “*Monetary conditions in this country had tightened considerably in the months before the Iraqi invasion of Kuwait.*” (BOE, Quarterly Bulletin, 1990, Vol. 30, No. 4, pg 442). It goes on to say:

“The tight policy stance with interest rates maintained at 15% throughout the third quarter, was reinforced by the appreciation of sterling, which was attributable in part to anticipation of ERM entry and, in the immediate aftermath of the Iraqi invasion of Kuwait, to a degree of petro-currency support.” (pg. 465).

The final episode identified for the UK was in September 1992, at the time of the ERM crisis. Britain left the ERM, unable to fend off a speculative attack on its currency, despite raising short term interest rates to 12%. Subsequently, the Bank of England lowered interest rates to help boost the domestic economy and mitigate the effects of the crisis.

United States

For the United States, four episodes are considered. These are given by the last four observations identified by Romer & Romer (1989), through their search of the FOMC meetings. It is only the availability of data which restricts attention to four of their six shocks. The first occurrence considered here is from mid 1967 till the end of 1968. Romer & Romer (1989) document evidence of concerns about inflation and inflationary expectations which led the Federal Reserve to tighten

monetary policy. The second shock arose from the first OPEC oil shock and the period considered is from the second quarter of 1974 till the first quarter of 1975. It was in April 1974 that the Federal Reserve tightened monetary policy to fend off rising inflation occurring from the oil embargo that started in October 1973. The third and fourth responses occurred back to back in August 1978 and October 1979. Monetary policy had started to be tightened since August 1978, but in October 1978, the Federal Reserve decided much stronger measures were required to combat inflation. This led to the announcement by the chairman of the Federal Reserve Board, Paul Volcker, of a change in the instrument of monetary policy to controlling non-borrowed reserves. Monetary policy was tightened further. Thus, the periods considered are the third quarter of 1978 till the second quarter of 1979, and from the fourth quarter of 1979 till the third quarter of 1980.

Movements Of Money Market And Implied CCAPM Rates During The Episodes

Twenty episodes were identified from the documentary evidence above, where central banks were actively pursuing monetary policy. The quarters when these episodes occurred are the shaded areas in figures (1) to (3). There are two ways to characterise the results. One method, is to consider how the money market and implied CCAPM rates moved, within the periods identified, as a direct result of implementing the new policy. Comparing the movements of the real money market and implied real CCAPM rates using this method, yields a somewhat, problematic result. This can be seen upon closer examination of the movements of these two rates within the periods identified, in figures (1)-(3). There appears to be some evidence to suggest that the two rates move in opposite directions during the monetary policy periods. This is sometimes clearly seen, as in the first episodes for France and Italy in figure (1), or the first episode for the UK in figure (2), and in some of the other episodes. Sometimes the real money market rate moves very little, whilst the implied real CCAPM rate moves a lot, as in the last two episodes identified for Japan in figures (1) - (3). However, it is often difficult to characterise the movements using this method, for example, in the second identified episode for the UK in figures (2) and (3). This is especially true for the episodes in the cases with habit.

Another method to characterise the results, is to examine what these rates are at the beginning and

end of the identified periods, and then evaluate the overall direction in which these two rates have moved during the period. This method provides a much clearer picture. Table 3 summarises these directional movements of the real money market and implied real CCAPM rates under all the three cases. The results show that the case with iid consumption growth outperforms the others. Under iid consumption growth, the two rates only go in opposite directions in 10 of the twenty episodes, compared to the baseline and joint lognormality cases, where they go in opposite directions in 14 and 12 episodes respectively. The results for the nominal rates are worse, with the rates going in opposite directions for 14 and 13 episodes in the baseline and joint lognormality cases, respectively.

In attempting to interpret these results, the following should be considered. Canada and the US are examples of two countries that had a negative correlation between the implied real CCAPM rate and the ex ante real money market rate in Table 1. Given the negative correlation, the result in Table 3 is not totally unexpected for these countries. In fact, despite the overall negative correlation for Canada, the two rates move in the same direction during the first identified episode and even in the second identified episode, under habit with iid consumption growth. However, the more interesting result can be seen for those countries that had a positive correlation in Table 1, namely for France and the United Kingdom. Despite the overall positive correlation between the two rates, they move in opposite directions in the majority of the episodes, and this can be seen to an extent in figures (1)-(3). These results are also reflected in Italy and to an extent for Japan. However, a different problem can also be noted in Japan. In the second and third identified episodes, faced with deflationary pressures, the Bank of Japan tried to stimulate the economy by lowering interest rates to record lows. What can be noted from figures 1(d)-3(d) is the large variability in the implied CCAPM rate, compared to the relatively low variability of the money market rate.

This is a slightly different issue, but it serves to highlight three problems in equating the money market rate to the implied CCAPM rate in the baseline version of the model with power utility. Two problems arise with regards to sample moments. Not only is a difference in the means of the two rates problematic, but equating the two rates also implies that they have similar variability. This can be seen in the results in Table 1. A third problem arises from the correlation between

the two rates and the relative direction in which the rates are moving. Under habit, the third problem still remains, given the correlations in Table (2) and the direction of movements of these two rates in the identified monetary policy periods in Table (3). These issues are all problematic for the transmission mechanism of monetary policy in NNS models, particularly since the results show the real money market and implied real CCAPM rates are moving in opposite directions in the majority of the indentified episodes. Furthermore, the results suggest that the inclusion of habit will not lead to a resolution of the issue, and that this problem is an enduring feature of NNS models.

Given the results above, the next step would be to try and explain the observed movements in money market and implied CCAPM rates. The identification methodology used in this section does suffer from one drawback. This type of identification methodology does not provide strong identification, in the sense that, resultant movements in money market and implied CCAPM rates cannot be purely attributed to a monetary policy shock. The observed movements in money market and implied CCAPM rates could have arisen as a result of a combination of monetary, fiscal and other types of policy, and not purely a result of monetary policy. For example in the second identified episode for France, the response of the real money market and implied real CCAPM rate during the Mitterand experiment, could be attributed to both a monetary tightening and fiscal expansion. In order to try and account for these other factors, the approach adopted within this paper is to implement another identificiation scheme that is widely used in the monetary literature. This econometric identification scheme using VARs, provides an approach that identifies exogenous monetary policy shocks, isolates the response in the money market rates, and allows the effects of the exogenous monetary shock to be traced out to its impact on key variables. Thus, VARs should control for any other policy factors leading to changes in the money market rate, e.g. fiscal policy, or from other endogenous monetary policy actions. Hence, any observed responses can be purely attributed to an exogenous monetary policy shock. This is the focus of the next section.

Table 3: Directional Movements Of Real Money Market & Implied Real CCAPM Rates

Case I : Baseline - Real Rates										Case II : Habit - Idr - Real Rates									
Date	CCAPM	MMR	After CCAPM	MMR	Direction of Movement CCAPM	MMR	Same Direction	Date	CCAPM	MMR	Before CCAPM	MMR	After CCAPM	MMR	Direction of Movement CCAPM	MMR	Same Direction		
Canada	1979-III	8.96	4.14	5.51	3.32	D	Y	1979-III	7.980	3.990	7.980	3.990	2.559	2.133	D	D	Y		
	1980-III	3.74	5.49	6.12	3.95	U	N		1990-III	5.662	7.027	5.662	3.814	5.872	D	D	Y		
France	1979-III	9.51	-1.31	8.10	1.00	U	N	1979-III	6.339	1.069	6.339	1.069	-0.236	D	D	Y			
	1981-I	3.83	5.63	7.89	4.88	U	N	1981-I	0.716	3.412	0.716	3.412	1.818	U	D	N			
	1982-III	5.33	9.74	4.13	5.78	D	Y	1982-III	1.495	11.408	1.495	2.491	4.779	U	D	N			
Italy	1979-III	9.96	-4.73	7.57	-2.28	U	N	1979-III	-4.660	-7.992	-4.660	-4.221	-3.352	U	U	Y			
	1982-III	4.20	10.39	5.51	4.60	U	N	1982-III	12.576	10.404	12.576	7.904	4.722	D	D	Y			
	1985-III	5.11	3.35	3.57	5.70	D	N	1985-III	2.188	3.974	2.188	2.767	6.271	U	U	Y			
Japan	1979-III	7.17	0.65	7.78	5.46	U	Y	1979-III	0.867	-0.072	0.867	0.158	5.914	D	U	N			
	1984-III	-4.92	1.62	-2.29	2.54	U	Y	1984-III	0.392	1.002	0.392	-1.238	0.095	D	D	Y			
	1988-II	11.78	2.47	3.07	3.36	D	N	1988-II	11.317	1.367	11.317	-8.895	11.917	D	U	N			
UK	1976-II	7.95	-0.43	9.30	-3.37	U	N	1976-II	2.06	-0.23	2.06	10.72	-1.39	U	D	N			
	1979-IV	5.71	-0.66	5.02	5.69	D	N	1979-IV	-0.18	-5.351	-0.18	14.864	9.103	U	U	Y			
	1988-II	8.01	2.50	3.99	3.67	D	N	1988-II	7.899	3.11	7.899	2.14	5.37	U	U	Y			
	1980-III	2.25	5.01	2.15	1.16	D	Y	1980-III	6.87	6.12	6.87	7.22	4.94	U	D	N			
	1982-III	6.14	6.68	7.87	2.83	U	N	1982-III	2.498	5.853	2.498	3.807	3.373	U	D	N			
US	1967-III	8.81	1.13	8.38	0.98	D	Y	1967-III	4.199	0.576	4.199	-0.224	1.674	D	U	N			
	1974-II	2.83	0.99	7.45	0.12	U	N	1974-II	6.726	1.651	6.726	5.407	1.590	D	D	Y			
	1978-III	8.80	0.71	3.44	1.22	D	N	1978-III	4.636	0.423	4.636	7.488	-0.692	U	D	N			
	1979-IV	1.70	2.77	5.55	1.35	U	N	1979-IV	4.507	1.302	4.507	5.680	0.670	U	D	N			

Case III : Habit - Lognormal - Real Rates									
Date	CCAPM	MMR	Before CCAPM	MMR	After CCAPM	MMR	Direction of Movement CCAPM	MMR	Same Direction
Canada	1979-III	8.23	3.99	-1.77	2.13	D	D	2.13	Y
	1980-III	-1.15	7.03	0.24	5.87	U	U	5.87	N
France	1979-III	9.19	1.07	5.91	-0.24	D	D	-0.24	Y
	1981-I	-7.57	3.41	4.66	1.82	U	U	1.82	N
	1982-III	-4.02	11.41	-5.36	4.78	D	D	4.78	Y
Italy	1979-III	-3.64	-7.99	-4.49	-3.35	D	U	-3.35	N
	1982-III	11.05	10.40	7.01	4.72	D	D	4.72	Y
	1985-III	0.81	3.97	0.52	6.27	D	U	6.27	N
Japan	1979-III	-0.45	-0.07	-0.31	5.91	U	U	5.91	Y
	1984-III	-13.25	1.00	-12.17	0.09	U	D	0.09	N
	1988-II	15.90	1.37	25.43	1.67	U	U	1.67	Y
UK	1976-II	2.58	-0.23	13.78	-1.39	U	D	-1.39	N
	1979-IV	3.48	0.49	-7.27	-2.08	D	D	-2.08	Y
	1988-II	4.42	3.11	-3.85	5.37	D	U	5.37	N
	1980-III	-2.29	6.12	-2.12	4.94	U	D	4.94	N
	1982-III	-1.09	5.85	3.77	3.37	U	D	3.37	N
US	1967-III	6.12	0.58	1.06	1.67	D	U	1.67	N
	1974-II	-5.44	1.65	3.95	1.59	U	D	1.59	N
	1978-III	6.50	0.42	-3.48	-0.69	D	D	-0.69	Y
	1979-IV	-9.60	1.30	-0.24	0.67	U	D	0.67	N

Summary of Directional Movements Of Both Nominal And Real Rates										
	Nominal	Case I	Case III	Real	Case I	Case II	Case III	Same Direction?	No	Yes
									14	6
									13	7
									14	6
									10	10
									12	8

Key:
D - Down
U - Up
Y - Yes
N - No

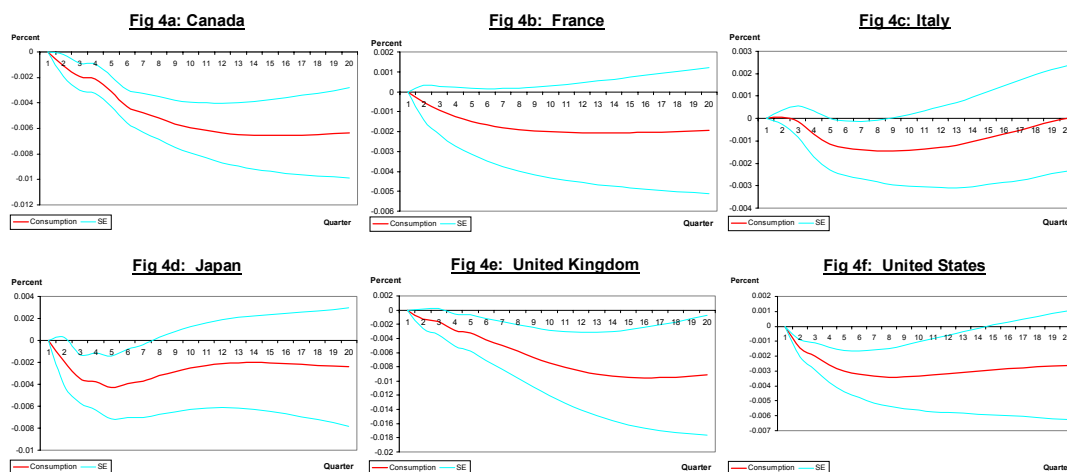
4 The Impact Of Monetary Shocks

This section employs an alternative methodology to trace out the effects of an exogenous monetary shock on key variables. This alternative methodology in analysing the effects of monetary policy shocks is provided by Christiano, Eichenbaum & Evans (henceforth CEE, 1999). CEE look at the impulse response functions arising from monetary policy shocks in VARs to examine the dynamic response of key variables, such as output, to such shocks. This econometric methodology is used in the hope that it can provide a qualitative answer for the direction of movement of the real money market and implied real CCAPM rates at the times of a monetary policy action. This paper follows their methodology in identifying and analysing the effects of monetary policy shocks. Here the monetary policy shock is assumed to originate from a change in the nominal interest rate, such as the Federal Funds rate. The VAR given by equation (4), is used to examine the impulse response functions of consumption and output arising from a money market rate shock. These dynamic responses are then used to try and explain the observed movements of the real money market and implied real CCAPM rates. Finally, this section also documents the response of the implied real CCAPM rate to a monetary policy shock.

The CEE monetary policy identification scheme focuses on a recursive ordering of the VAR. In particular, the central bank is assumed to follow a feedback rule for the money market rate: $i_t = f(\Phi_t) + S_t$ where Φ_t summarises the information set available to the central bank, and S_t is a serially uncorrelated shock that is orthogonal to the elements of Φ_t . This recursiveness assumption means that the instrument of monetary policy, i_t is contemporaneously affected by variables in the information set of the central bank, Φ_t , but those variables themselves are not contemporaneously affected by the monetary policy shock. This recursiveness assumption boils down to the fact that the variables in the feedback rule are incorporated ahead of the monetary policy shock variables within the VAR. Variables after i_t , are hit contemporaneously from a change in the money market rate. Thus considering the VAR in equation (4):

$$Z_t = [c_t \ \pi_t \ y_t \ i_t \ m_t]'$$
 (11)

Figure 4: Impulse Response Of Consumption From A 1% Change In The Money Market Rate.



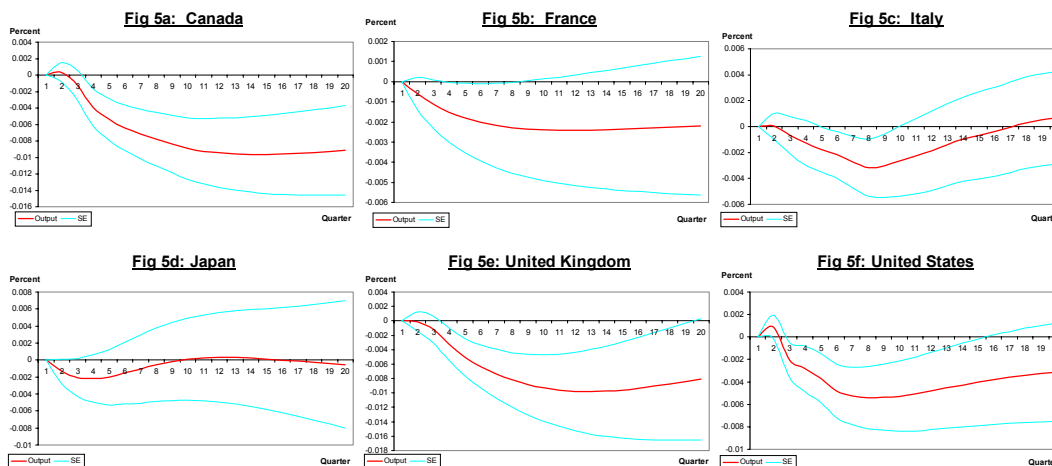
The logs of real consumption, inflation, and real output are assumed to be in the information set of the central bank and thus affected with a delay. The monetary aggregate is assumed to respond contemporaneously as the central bank adjusts reserves to keep the monetary aggregate consistent with the money market rate.

The objective at this point is to document the dynamic responses of consumption, inflation and output from a monetary policy shock, and thus have an idea as to the direction in which the data suggests these variables may be moving. The impulse response functions of consumption, and output, along with their monte carlo generated standard errors, are shown in figures (4) and (5) respectively.

In general, the results show the usual ‘hump-shaped’ response of consumption and output found in the literature. That is, an unexpected monetary tightening leads to a fall in consumption and output. The impact is not immediate, but instead the trough occurs several periods afterwards and these vary from country to country. The results from the impulse responses of consumption are all significant with the exception of France, whose standard errors suggest that the dynamic response of consumption may not be significantly different from zero.

The impulse responses of inflation from an increase in the money market rate, also showed a hump-shaped response, although it is not reported here (see Ahmad, 2002). Inflation increased initially

Figure 5: Impulse Response Of Output From A 1% Change In The Money Market Rate.



as a result of the money market rate shock, and then declined several quarters later. This is true for all the countries with the exception of Italy. Inflation in Italy actually falls and then increases later. Furthermore, the results for Italy and France had sufficiently large standard errors which implied that the impulse response function may not be significantly different from zero. For output, all the countries with the exception of Japan, have significant impulse responses suggesting that an unexpected monetary tightening leads to a fall in output, which is consistent with the literature.

There are a few key results above. Namely, the impact of an unexpected monetary shock on consumption tomorrow is negative. Furthermore, consumption the day after falls even more. As a result, the impact on the growth rate of consumption from an unexpected monetary policy shock is negative and stays negative for some time. If the Euler equation held, then in the equation (2) above, a change in the nominal interest rate arising from a central bank policy action, would have a direct impact on expected consumption growth and expected inflation, and these are predicted in these NNS models (e.g. Rotemberg and Woodford, 1997).⁷ However, as noted in the earlier sections, the problem within NNS models are its implications for the direction of movement of the money market and the implied CCAPM rate. These results manage to shed some light on the nature of this problem.

⁷Some evidence of this is provided in Fuhrer (2000), who shows by simulation, that an implication of these types of models are that consumption and inflation respond immediately to such shocks.

The basic intuition can be seen by abstracting initially from inflation. Consider equation (3).

$$\frac{1}{1+r_t} = \beta E_t \left[\left(\frac{C_t}{C_{t+1}} \right)^\theta \right] \equiv \frac{1}{1+r_t^*}$$

As mentioned above, the direct implication is that the left hand side falls as a result of an unexpected monetary contraction. The identification scheme within the VAR holds consumption today constant, but consumption tomorrow falls. Furthermore, consumption the day after falls even more. Thus, both consumption growth and expected consumption growth falls for a period of time and as a result, $E_t \left[\left(\frac{C_t}{C_{t+1}} \right)^\theta \right]$ increases. This in turn implies that the implied real CCAPM rate has moved in the opposite direction to the real interest rate, and fallen.

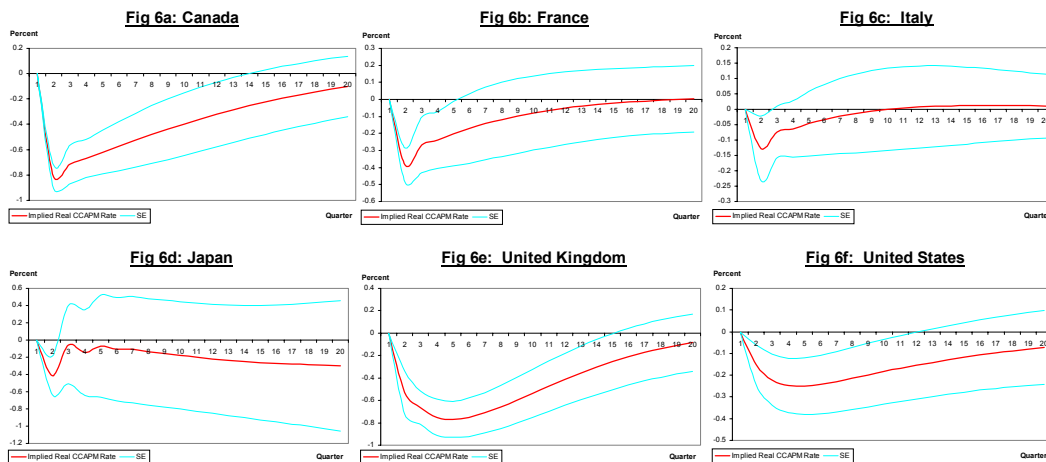
$$\frac{1}{1+i_t} = \beta E_t \left[\left(\frac{C_t}{C_{t+1}} \right)^\theta \frac{P_t}{P_{t+1}} \right] \equiv \frac{1}{1+i_t^*}$$

Incorporating inflation only complicates the story a little. Consider the nominal Euler equation (2) above. An unexpected monetary contraction reduces the left hand side of the equation. However, the right hand side may or may not increase since consumption growth falls, but inflation increases. However, the degree to which the right hand side increases or decreases depends on the expectation of the relative magnitude of the fall in consumption growth compared to the increase in inflation. Since the relative response of inflation from a money market rate shock was much less than that of consumption in all the countries, the implication is that the right hand side of the Euler equation rises. Hence, the response of the implied CCAPM rate is negative to an unexpected monetary tightening.

Moreover, the resultant movement of the implied CCAPM rate arising from an unexpected monetary shock can be directly verified. Consider the effect of a monetary policy shock on the implied CCAPM rate within the ordered VAR presented before. Including the implied CCAPM rate within the VAR allows us to check the direction in which the implied CCAPM rate may be moving. Thus, modifying the VAR in equation (11) as follows:

$$Z_t = [c_t \ \pi_t \ y_t \ r_{t-1}^* \ i_t \ m_t]' \tag{12}$$

Figure 6: Impulse Response Of The Implied Real CCAPM Rate From A 1% Change In The Money Market Rate Across Countries.

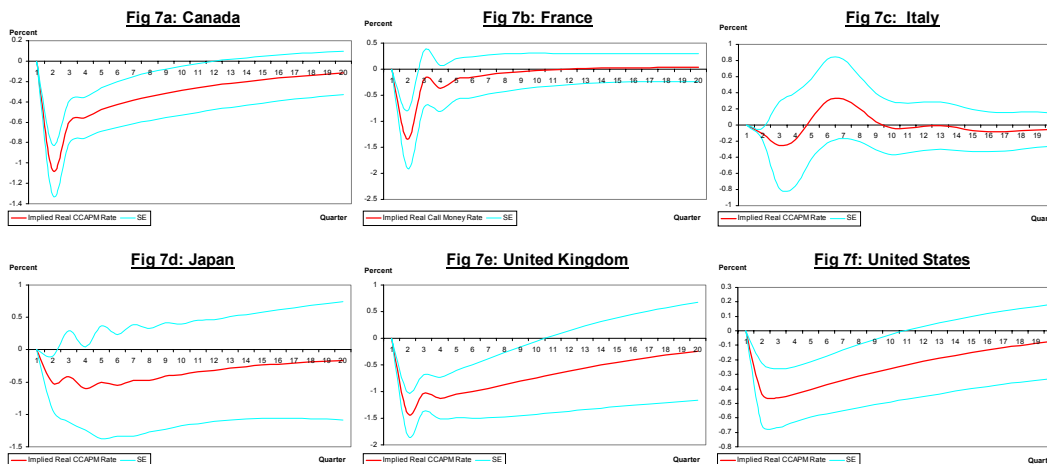


where r^* is defined according to the right hand side of equation (3). The impulse response function of the implied CCAPM rate arising from a monetary policy shock can then be directly examined.

The results for response of the implied real CCAPM rate are shown in figure (6) and are quite striking. In all the cases, the implied real CCAPM rate falls as a result of an unexpected monetary contraction. The results for the nominal implied CCAPM rate have been omitted since they are very similar and convey the same information. So, in the baseline case of power utility, there is strong evidence which supports the conclusion that the money market and implied CCAPM rates are moving in different direction as a result of an unexpected monetary policy shock. The results for the version of the model with habit are depicted in figures (7) and (8) below. The implied real CCAPM rate used in the VAR here, r_{t-1}^* , is the one constructed from equation (9), but under the two distributional assumptions for consumption growth.

The results here seem consistent with the explanation presented above. Consider figure (7) first, where consumption growth and inflation are jointly conditionally lognormally distributed. The impulse responses show that the implied real CCAPM rate falls as a result of an increase in the money market rate in every country. The results for the implied nominal CCAPM rate are similar to the implied real CCAPM rate and not reported here. Thus, the results in this case are similar

Figure 7: Impulse Response Of The Implied Real CCAPM Rate Under Habit With Joint Lognormal Consumption Growth Across Countries.

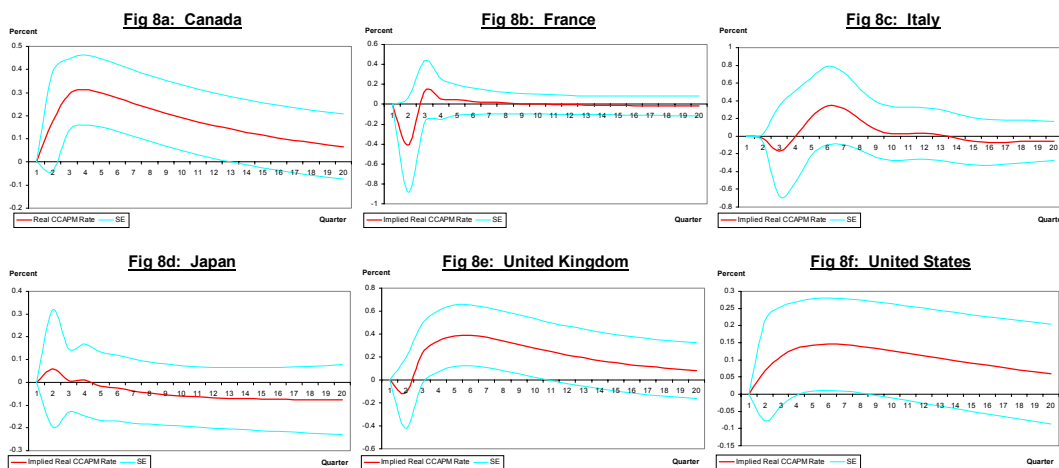


to those in the baseline case. They suggest that the implications of the dynamics of consumption and inflation, even with habit persistence, are insufficient to resolve the puzzle that arises for the movements of money market and implied CCAPM rates.

The best results occur once again in the case where consumption growth is counterfactually assumed to be iid, as can be seen in figure (8). The implication when consumption growth is iid, is that in this case, the expected value of consumption growth tomorrow is the same as that today. Since both the expectation and variance terms are constant, considering the implied real CCAPM rate in equation (9), the right hand side of the implied real CCAPM rate just consists of a constant term and today's value for consumption. Hence, any change in the implied real CCAPM rate should only arise from realisations of this period's value of consumption.

The model seems to work better in this iid case because it abstracts the effects of monetary policy on expected consumption growth present in the data. These results are borne out in the plots for France, Italy and Japan which show that an increase in the money market rate does not have a significant impact on the implied real CCAPM rate. Canada, the UK and the US in fact show a slight increase in the implied real CCAPM rate with the peak about 4-6 quarters. The marginally better results in this iid case are also reflected in the larger (and more positive) values of the correlation in Table 2 and the results in Table 3, when comparing them to the baseline or joint

Figure 8: Impulse Response Of The Implied Real CCAPM Rate Under Habit With iid Lognormal Consumption Growth Across Countries.



lognormality cases. Overall, the evidence here suggests that the money market and implied CCAPM rates cannot be reconciled through the Euler equation and models which break the link between the instrument of the central bank and the implied CCAPM rate might succeed in resolving these problems.

5 Conclusions

This paper examines the transmission mechanism of monetary policy in NNS models in terms its implications for movements in money market and implied CCAPM rates. A recent finding by Canzoneri, Cumby and Diba (2002) showed the Fed Funds rate to be negatively correlated with the implied CCAPM rate. Their result has a serious implication for the transmission mechanism in NNS models, which equates the money market rate to the implied CCAPM rate from a consumption Euler equation. Monetary policy works through changes in the instrument - the nominal interest rate, and has an impact on the real variables in an economy through its impact on expected consumption growth in the presence of a nominal rigidity, like sticky prices. The essence of the problem is thus quite stark. A negative correlation between money market and implied CCAPM rates indicates a problem in modeling the transmission mechanism of monetary policy through the

consumption Euler equation. One possible avenue in addressing this issue involves changing agent's preferences since the problem lies within the demand side of the economy. This avenue is considered here within the paper by incorporating habit persistence into the utility function.

This paper constructs and compares the movements of implied real CCAPM rates to real money market rates, during identified monetary policy periods, for six of the G7 countries. This is done for three cases:- a baseline case with power utility, against two alternatives that incorporate habit under two different distributional assumptions for consumption growth and inflation. The results yield correlations that are low and often negative between the two rates. Moreover, the two rates are found to move in opposite directions in the majority of the identified monetary policy periods.

The paper proceeds by using the Christiano et al (1999) VAR methodology to identify and isolate the effects of an exogenous monetary policy shock. Impulse response functions from a money market rate shock yield hump shaped responses for consumption, inflation and output. These results suggest a possible explanation for the low and negative correlations observed. An unexpected monetary tightening leads to a fall in consumption growth. Hence, expected consumption growth falls, leading to a fall in the implied CCAPM rate. This is verified by examining the impulse response of the implied CCAPM rate from an unexpected monetary tightening, which is found to be negative.

Overall, the results in the paper are problematic for the transmission mechanism of monetary policy in NNS models that equate the money market rate to the implied CCAPM rate. They imply that a consumption Euler equation from a model with power utility cannot reconcile the direction of movements of the money market and implied CCAPM rates, even with habit persistence. The best results are found in the case when consumption growth is naively assumed to be iid, since this case abstracts from the effects of monetary policy on expected consumption growth. The results here, suggest more work should be done in developing models which break this link in the transmission mechanism, using for example, limited participation.

Appendix

A The Dataset

The dataset consists of quarterly data on the following variables for each of the countries: nominal and real nondurable goods and services along with their deflators; nominal and real GDP again along with their deflator; a commodity price index; a monetary aggregate; and a money market rate. The sources are presented as follows:

A.1 Interest Rates and Monetary Aggregates

Interest rate data are obtained from the following sources: *OECD Main Economic Indicators* for France and Italy; *OECD Economic Indicators Database* for Canada and the United Kingdom. These data are all quarterly. Interest rate data for Japan was provided by John Rogers and comes from the *International Financial Statistics Database*. The US data is obtained from the *Federal Reserve Statistical Release* within the historical data section. The data is monthly and so converted to quarterly by taking three month averages. The monetary aggregates for all the countries with the exception of the US is also obtained from the OECD's *Main Economic Indicators*. US monetary aggregates are obtained from the *Federal Reserve Statistical Release* and again the data is converted to quarterly by taking three month averages.

A.2 Consumption, And GDP Data

Both the consumption and GDP data are quarterly data. They include both nominal and real consumption spending on nondurable goods and services along with their implicit deflators, and nominal and real GDP along with their price deflators. These are obtained from the *OECD Quarterly National Accounts* for Canada, France, Italy and Japan. The data for the *OECD Quarterly National Accounts* use the fixed-weight standard of the 1993 SNA and base years vary according to country. For the UK, the data is obtained from the UK's Office of National Statistic's *Quarterly National Accounts*. For the US, the data is obtained from the Bureau of Economic Analysis' *National Income and Products Accounts*. However, the US data is chain weighted which ensures that

the prices used to compute the values are never too far out of date.

A.3 Price Data

For Canada, France, Italy and Japan, and the UK the nominal (real) nondurable consumption goods and services are summed to create nominal (real) consumption, and the price level is the implicit deflator between the nominal and real consumption series. However, for the US, the chain-weighted components are not additive. To create the consumption based price index, the nominal expenditures on nondurable goods and services are summed to give nominal expenditures on consumption. Similarly, each of the individual nominal expenditure series on nondurables and services are divided by their implicit price deflators and these real based measures are summed to give real consumption expenditure. The nominal consumption based series is then divided by the real consumption based series to yield the consumption based price index.

A.4 Other Data

The other data series included in the dataset are a measure of a share price index and stock returns for each of the countries. The share price indices are included in the VAR so as to be able to alleviate the price puzzle. These are: the TSE 300 composite share price index for Canada; the SBF 250 Share Price Index for France; the MIB Share Price Index for Italy; the TSE TOPIX Share Price Index for Japan; the FTSE Non-Financial Share Price Index, and the Common Stock NYSE Share Price Index. All the data are seasonally adjusted with the exception of Japan. Data for Japan were seasonally adjusted before any analysis. The data for stock returns were calculated from yields and stock price indices from *Morgan Stanley Capital International Perspective*. It was generously provided by Robert Cumby.

A.5 Country Table

The following table gives the start and end dates of the common sample of all the variables:

<u>Country</u>	<u>Time Period</u>
Canada	1962:1 - 2000:2
France	1977:4 - 1998:2
Italy	1974:4 - 1998:3
Japan	1970:1 - 1999:1
United Kingdom	1969:1 - 2000:4
United States	1964:3 - 2000:4

A.6 Episodes of Monetary Policy Shocks

This table summarises the episodes where the central banks in these countries were observed to be moving the interest rate in their conduct of monetary policy.

<u>Country</u>	<u>Episodes Of Monetary Policy Shocks</u>		
Canada	1979:3-1980:2	1990:3 - 1991:2	
France	1979:3-1980:2	1981:2 - 1982:1	1992:4 - 1993:3
Italy	1979:3 - 1980:2	1992:3 - 1993:2	1995:3 - 1996:2
Japan	1979:3 - 1980:2	1994:3 - 1995:2	1998:2 - 1999:1
United Kingdom	1976:2 - 1977:1	1979:4 - 1980:3	1988:2 - 1989:1
	1990:3 - 1991:2	1992:3 - 1993:2	
United States	1967:3 - 1968:2	1973:4 - 1974:3	1978:3 - 1979:2
	1979:4 - 1980:3		

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