The Effects of Monetary Policy under Habit Persistence: A Two-Country Analysis

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Abstract We generalize a new open economy macroeconomics model by allowing for habit formation in consumption decisions and show that habit formation plays an important role in determining consumption changes to monetary shocks. The main findings of our analysis are that i) an increase in the importance of habit formation weakens the response of relative consumption to monetary policy shocks, and ii) the impact of an increase in the importance of habit formation on the equilibrium exchange rate change is ambiguous.

Keywords: Habit formation, consumption, exchange rate, monetary policy

JEL classification: E52, F31, F41

1. Introduction


In addition, in the last two decades, motivated by this empirical evidence, habit persistence in consumption preferences has been incorporated extensively at a theoretical level. Such studies include Abel (1990, 1999), Constantinides (1990), Detemple and Zapatero (1991), Heaton (1993, 1995), Chapman (1998), and Campbell and Cochrane (1999, 2000) in the asset pricing models; Carroll et al. (1997, 2000), Alvarez-Cuadrado et al. (2004), Alonso-Carrere et al. (2005), and Chen (2007) in the endogenous growth models; Obstfeld (1992), Mansoorian (1993a, 1993b, 1996, 1998), Ikeda and Gombi (1998), McCallum and Nelson (1998), and Gruber (2002, 2004) in the small open economy models; Malley and Molana (2002), Gomes and Michaelides (2003), Lupton (2003), Bodie et al. (2004), and Polkovnichenko (2007) in the life cycle models; Boldrin et al. (2001) in the real business cycle model; Diaz et al. (2003), Gombi and Ikeda (2003), and Pijoan-Mas (2007) in the heterogeneous agents’ models; Christiano et al. (2005), Faria (2001), and Auray and Fève (2008) in the monetary models. The aim of these studies is to improve the ability of the model in question to account for several empirical findings that could not be explained by the
traditional model in which preferences are time separable. For example, in the asset pricing literature, habit formation has a very important role in providing a solution to the “equity premium puzzle” identified by Mehra and Prescott (1985). In addition, habit formation has a very important role in an endogenous growth model in terms of replicating the positive relationship between output growth and saving (see, for example, Carroll et al. (1997, 2000)).

Although a large number of theoretical studies have been undertaken on the effects of habit formation in many areas of economics, no study has attempted to introduce the hypothesis of habit formation into the new open economy macroeconomics (NOEM) models. The purpose of this paper is to contribute to the theoretical aspect of macroeconomics literature by generalizing a NOEM model to include habit formation. In addition, we examine the question of how the strength of habit formation affects the response of both consumption and the exchange rate to monetary policy shocks, particularly in comparison with those predicted by the benchmark NOEM model (e.g., Obstfeld and Rogoff (1995)), in which habit formation is ignored.

In related works, using calibration methods, Fuhrer (2000) succeeded in showing the gradual hump-shaped responses of both consumption and inflation to monetary and other shocks. Christiano et al. (2005) considered the dynamic effects of monetary policy shocks under nominal rigidities. They showed a persistent response in output and succeeded in replicating the observed inertial response in inflation. However, they ignored the impacts of a shock to a monetary expansion on the exchange rate and the foreign country’s consumption because they employed a closed economy setting. On the other hand, Obstfeld (1992), Mansoorian (1993a, 1993b, 1996, 1998), Ikeda and Gombi (1998), McCallum and Nelson (1998), and Gruber (2002) considered, in detail, the implications of habit formation for open economy models in which international markets for goods and bonds are open. However, because they began with the assumption of a small open economy, they could not consider the impact of one country’s monetary policy shock on another country through the adjustment of the exchange rate.

The remainder of this paper is structured as follows. In Section 2, we outline the features of the dynamic optimizing model. In Section 3, we present the symmetric equilibrium with flexible nominal prices. In Section 4, we present a log-linearized version of this model, and examine how the importance of habit formation affects the responses of both relative consumption and the exchange rate to monetary policy shocks. The final section summarizes the findings and concludes the paper.

2. Model Structure

We assume a two-country world economy, with a home and a foreign country. The models for the foreign and home countries are the same, and an asterisk is used to denote foreign variables. There is monopolistic competition in the markets for goods, whereas the international bond market is perfectly competitive. As in the NOEM literature, a continuum of the population in the world is assumed to be composed of consumer producers (i.e., as in a yeoman farmer economy). The size of the world population is normalized to unity. In addition, we assume that households in the home country inhabit the interval [0, n] and those in the foreign country inhabit the interval (n, 1]. The home and foreign households have perfect foresight and households in each
country derive their utility from consuming a group of differentiated goods (defined later), gain from money holdings through liquidity services, and incur the cost of expending labor effort. The key feature of our model is the inclusion of habit formation in the households’ consumption behavior. With habit formation, for a given level of current consumption, the household’s current consumption utility depends negatively on the level of habit determined by past consumption. Following the formulation in Abel (1990), we assume that households’ utility at time $t$ is affected by the habit stock multiplicatively, $[(C_t/(h_t) \theta \gamma - 1)](1 - \gamma)$, where $C_t$ is the household’s own consumption in period $t$, $h_t$ is the level of habit, the parameter $\kappa$ (we assume $0 \leq \kappa < 1$) measures the importance of habit formation in the utility function, and $\gamma$ is the coefficient of relative risk aversion, where $\gamma > 1$ is assumed. In this specification, for $0 < \kappa < 1$, when $\kappa$ is larger, the household receives less consumption utility from a given amount of current consumption. In addition, following Abel (1990) and Graham (2008), we take the level of habit $h_t$ to be equal to the household’s own previous-period consumption: $h_t = C_{t-1}$. The intertemporal objective of household $i \in (0, n)$ in the home country at time 0 is to maximize the following lifetime utility:

$$U_0 = \sum_{t=0}^{\infty} \beta^t \left( [(C_t/(C_{t-1}) \theta \gamma - 1)](1 - \gamma) + \chi \log(M_t/P_t) - (\eta/2)(y_t(i))^2 \right),$$

where $0 < \beta < 1$ is a constant subjective discount factor, $y_t(i)$ is the amount of an individual’s output in period $t$, and the consumption index $C_t$ is defined as follows:

$$C_t = \left( \int_0^t C_t(i)^{(1-\theta)d} \right)^{\theta/(1-\theta)}, \theta > 1,$$

where $\theta$ is the elasticity of substitution between any two differentiated goods and $C_t(i)$ is the consumption of good $i$ in period $t$. In addition, the second term in (1) represents real money balances ($M_t/P_t$), where $M_t$ denotes nominal money balances held at the beginning of period $t + 1$, and $P_t$ is the home country consumption price index (CPI), which is defined as $P_t = \left( \int_0^t P_t(i)^{1-\theta} \right)^{1/(1-\theta)}$, where $P_t(i)$ is the home currency price of good $j$ in period $t$. Analogously, the foreign country’s CPI is $P_t^* = \left( \int_0^t P_t(i)^{1-\theta} \right)^{1/(1-\theta)}$, where $P_t^*(i)$ is the foreign currency price of good $i$ in period $t$. Because there are no trade costs between the two countries, the law of one price holds for any variety $i$, i.e., $P_t(i) = \varepsilon_t P_t^*(i)$, where $\varepsilon_t$ is the nominal exchange rate, defined as the home currency price per unit of foreign currency. Given the law of one price, a comparison of the above price indexes implies that purchasing power parity (PPP) is represented by $P_t = \varepsilon_t P_t^*$. A typical domestic household faces the following budget constraint:

$$P_tB_{t+1} + M_t = P_t(1+r_t)B_t + M_{t-1} + P_t(i)y_t(i) - P_tC_t + P_t\tau_t,$$

where $B_{t+1}$ denotes real bonds held by home agent $i$ in period $t + 1$, $r_t$ denotes the real interest rate on bonds that applies between periods $t - 1$ and $t$, $P_tC_t$ represents nominal consumption expenditure, $\tau_t$ denotes real lump-sum transfers from the government in period $t$, and all variables are measured in per capita terms. In the government sector, we assume that government spending is zero and that all seignorage revenues derived from printing the national currency are rebated to the public in the form of lump-sum transfers.
Now, we consider the dynamic optimization problem of households. Following the NOEM literature, we solve the dynamic problem by dividing it into two stages for clarity. In the first stage, households in the home (foreign) country maximize the consumption index $C_t (C_t^*)$ subject to a given level of expenditure $P_t C_t = \int_0^1 P_t^i(i) C_t(i) di$ ($P_t^* C_t^* = \int_0^1 P_t^*(i) C_t^*(i) di$) by optimally allocating differentiated goods. This static problem yields the following demand functions for good $i$ in the home and foreign countries, respectively:

$$C_t^i = (P_t^i/P_t)^{-\theta} C_t^i, \quad C_t^*(i) = (P_t^*(i)/P_t^*)^{-\theta} C_t^*.$$  \hfill (3)

Aggregating the demands in (3) across all households worldwide and equating the resulting equation to the output of good $i$ produced in the home country, $y_t(i)$, yields the following market clearing condition for any product $i$ in period $t$:

$$y_t(i) = nC_t^i(i) + (1 - n)C_t^*(i) = (P_t^i/P_t)^{-\theta} C_t^w,$$  \hfill (4)

where $P_t^i/P_t = P_t^*(i)/P_t^*$ from the law of one price, and $C_t^w \equiv (nC_t + (1 - n)C_t^*)$ is aggregate per capita world consumption. Similarly, for product $i$ in the foreign country, we obtain $y_t^*(i) = nC_t(i) + (1 - n)C_t^*(i) = (P_t^*(i)/P_t^*)^{-\theta} C_t^w$. In the second stage, households maximize (1) subject to (2). In this maximization problem, we assume that the households take into account the effect of negative habit formation on future utility by increasing their current consumption. Then, the first-order conditions for this problem with respect to $B_{t+1}$, $M_t$, and $y_t(i)$ can be written as:

$$1 = \kappa \beta (C_{t+1}/C_t)^{1-\gamma} (C_{t-1}/C_t)^{\kappa (1-\gamma)} + \beta (1 + r_{t+1}) (C_{t+1}/C_t)^{-\gamma} (C_{t-1}/C_t)^{\kappa (1-\gamma)},$$  \hfill (5)

$$M_t/P_t = \chi C_t^i C_{t-1}^{\kappa (1-\gamma)} \{ [\kappa (C_{t+1}/C_t) + (1 + r_{t+1})] /[ (1 + r_{t+1}) - (P_t/P_{t+1})] \},$$  \hfill (6)

$$y_t(i)^{(\theta+1)/\theta} = (\theta-1)/\theta \kappa (C_t^w)^{(1-\gamma)/\gamma} (1/(C_{t-1})^\kappa - \kappa \beta (C_{t+1}/C_t)^{(1-\gamma)} (1/C_t),$$  \hfill (7)

where equation (5) is the Euler equation for consumption, (6) is the one for money demand, and (7) is the labor–leisure tradeoff condition. These equations, (5), (6), and (7), are the same as that in Obstfeld and Rogoff’s model when $\kappa = 0$ and $\gamma = 1$.\textsuperscript{10} As stated in Obstfeld and Rogoff (1995), equation (6) is the money market equilibrium condition that equates the marginal rate of substitution between consumption and money holdings (i.e., the benefit from holding real money balances) to the consumption opportunity cost of holding money. Moreover, note from equation (6) that the demand for real money balances becomes larger for higher values of $\kappa$. This is because an increase in the values of the parameter $\kappa$ reduces the marginal utility of consumption, and thereby raises the marginal rate of substitution between consumption and money holdings. The equilibrium condition for the integrated international bond market is given by

$$nB_{t+1} + (1 - n)B_t^* = 0.$$
3. A Symmetric Steady State

Henceforth, we denote the steady-state values by using the subscript ss. In the symmetric steady state in which all exogenous variables are constant, initial net foreign assets are zero \( B_0 = 0 \), given equation (5), the constant real interest rate is given by:

\[
  r_{ss} = \frac{(1 - \beta(1 - \kappa))}{\beta} \equiv \delta,
\]

where \( \delta \) is the rate of time preference and \( r_{ss} \) is the steady-state real interest rate. In addition, from (7), we obtain:

\[
  C_{ss} = C^*_ss = C^w_{ss} = y_{ss}(h) = y_{ss}^*(f) = \left[ ((\theta - 1)/\theta \kappa)(1 - \kappa \beta) \right]^{1/(1 + \gamma + \kappa(1 - \gamma))}.
\]

Equation (9) shows that not only do all households worldwide produce the same amount of output, it also shows that all households worldwide consume this output.

4. A Log-Linearized Analysis

Now, we consider the macroeconomic effects of a one-off unanticipated infinitesimal permanent increase in the relative level of the home money supply in period 1. To examine the effects of monetary policy shocks, we solve a log-linear approximation of the system around the initial, zero-shock steady state, with \( B_{ss,0} = 0 \). For any variable \( X \), we use \( \hat{X} \) to denote ‘short-run’ percentage deviations from the initial steady-state value and \( \bar{X} \) to denote ‘long-run’ percentage deviations from the initial steady-state value. Following Obstfeld and Rogoff’s graphical analysis, we derive the following MM and GG schedules:

\[
  \hat{e} = \hat{M} - \hat{M}^* - \left\{ \gamma + \frac{\kappa(\gamma - 1)(\delta \kappa + \gamma(\kappa + 1 + \delta))}{(1 + \delta)(\kappa + 1 + \delta)(\gamma - \kappa \beta)} \right\}(\hat{C} - \hat{C}^*) : \text{MM schedule},
\]

\[
  \hat{\varepsilon} = \left( \frac{1}{\theta - 1} \right)^{\left( \left( \frac{1}{\delta} \right)^{\left( \frac{\theta - 1}{\theta + 1} \right)} \left( \gamma + \frac{\beta \kappa^2(\gamma - 1)}{\gamma - \kappa \beta} \right)^{\left( \frac{\kappa(\gamma - 1)}{\gamma - \kappa \beta} \right) + 1} \right)}(\hat{C} - \hat{C}^*) : \text{GG schedule}.
\]

The effects of expansionary monetary shocks are represented in Figure 1, in which the solid line, labeled MM, represents the pre-shock equilibrium, in which \( \hat{M} - \hat{M}^* = 0 \), and the line, labeled MM’, is the post-shock MM schedule. The short-run equilibrium exchange rate and the change in relative consumption lie at the intersection of the MM and GG schedules (point E). As a result, Figure 1 shows that both the exchange rate and domestic relative consumption level rise when there is an unanticipated relative home country monetary expansion. The above result is similar to that obtained by Obstfeld and Rogoff (1995), in which habit formation was ignored.

However, in the present model, habit formation plays an important role in determining consumption changes in response to monetary shocks. Figure 1 shows that, from equations (10) and (11), both the MM’ and GG schedules sharpen as \( \kappa \) increases (shown as broken lines) and
the equilibrium point moves from \( E_1 \) to \( E_2 \). This implies that an increase in \( \kappa \) reduces the effect of a monetary shock on relative consumption. In other words, the larger is the importance of habit formation, the more sluggish is the response of relative consumption levels to a monetary shock. Intuitively, an unanticipated monetary expansion in the home country requires an instantaneous depreciation of its currency to restore money market equilibrium for a given level of initial relative consumption. Then, the exchange rate depreciation causes consumption switching, as world consumption demand shifts towards home goods because of the fall in their relative price. This demand shift raises relative home production, which in turn raises relative home consumption. However, as the importance of habit formation becomes larger, the marginal utility of consumption is more strongly decreasing in the habit stock and, therefore, home country people are likely to consume less, and increase international bonds through saving to maximize their lifetime utility. Therefore, an increase in the importance of habit formation weakens the effect of monetary policy shocks on relative home consumption. The opposite mechanism is valid: the smaller is the value of \( \kappa \) (if habit becomes less important), the larger is the response of relative consumption levels to the monetary shock.

Furthermore, from equations (10) and (11), the exchange rate effect of a monetary expansion is:

\[
\hat{e} = \left( \frac{\tilde{\theta}}{1 + \tilde{\theta}} \right) \left( \frac{\hat{M} - \hat{M}^*}{1 + \hat{\theta}} \right),
\]

where:

\[
\tilde{\theta} \equiv \left( \frac{\gamma}{\theta - 1} \right) \left[ \frac{1}{\delta} \left( 1 + \frac{\theta - 1}{\theta + 1} \left( \gamma + \beta \kappa^2 (\gamma - 1) \right) \right)^2 \left( 1 + \frac{\kappa (\gamma - 1)}{\gamma - \kappa \beta} \right) + 1 \right] > 0,
\]

and

\[
\tilde{\gamma} \equiv \left( \gamma + \frac{\kappa (\gamma - 1) \left[ \delta \kappa + \gamma (\kappa + 1 + \delta) \right]}{(1 + \delta) (\kappa + 1 + \delta) (\gamma - \kappa \beta)} \right)^{-1} > 0.
\]

From (12), the impact of an increase in the importance of habit formation (which corresponds to an increase in the value of \( \kappa \)) on the response of exchange rate to a monetary shock is ambiguous. This is because the impact of an increase in the importance of habit formation is determined by two conflicting mechanisms. The intuition of these two mechanisms is as follows. On the one hand, an increase in the importance of habit formation induces people to consume less. This is because, when the importance of habit formation is larger, the marginal utility of consumption is more strongly decreasing in the habit stocks and, therefore, home country people have an incentive to consume less if people are optimizing. Hence, the home currency must depreciate to restore equilibrium in the market for real balances. This is because the real money demand for liquidity services is increasing in aggregate consumption (as implied by equation (6)). On the other hand, an increase in the importance of habit formation decreases the marginal utility of consumption for a given amount of consumption, and thereby increases the marginal rate of substitution between consumption and money holdings. The marginal rate of substitution between consumption and money holdings can be interpreted as the benefit from holding real money balances. Therefore, an increase in the importance of habit formation induces people to increase their real money holdings. Because of this effect, the home currency must appreciate
to restore equilibrium in the market for real balances. Accordingly, for these two opposing influences on the exchange rate, the impact of an increase in the importance of habit formation on the response of the equilibrium exchange rate to changes in the money supply becomes ambiguous.

5. Conclusions

In this paper, we have provided a generalization of Obstfeld and Rogoff’s (1995) model, which allows for multiplicative form of habits in consumption. We have used this generalized model to consider the question of how allowing for habits changes the response of both consumption and the exchange rate to monetary policy shocks. The main findings of our analysis are that i) an increase in the importance of habit formation weakens the effect of monetary policy shocks on relative home consumption, and ii) the impact of an increase in the importance of habit formation on the equilibrium exchange rate change is ambiguous.

Finally, this paper has simply analyzed the effects of an increase in the importance of habit formation in consumption preferences. The paper would yield more interesting results if the present model were extended to a model with habit-forming labor supply, as in Bover (1991) and Kubin and Prinz (2002). In addition, this paper has focused on considering the theoretical aspects of the NOEM model with habit formation. Therefore, whether the results of this paper are consistent with empirical evidence is the question that we must consider next. These issues remain for future research.

Endnotes

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1. Additionally, Heien and Durham (1991), Lupton (2003), Carrasco et al. (2005), and Ravina (2005) provided evidence regarding the significance of habit formation in microdata.

2. The puzzle states that, given the observed growth rate of per capita consumption, the risk premium (the difference between the average equity return and the average risk-free rate) is too large under plausible values of risk aversion.

3. This positive relationship states that higher growth results in higher saving. Empirical evidence suggests that this positive correlation holds (see, for example, Carroll and Weil (1994)).

4. A growing number of studies in the NOEM literature have focused on how the macroeconomic activity of each country and the exchange rate are influenced by monetary policy shocks under monopolistic distortions and price rigidities; see, e.g., Obstfeld and Rogoff (1995), Lane (1997), Betts and Devereux (2000), Hau (2000), Bergin and Feenstra (2001), Corsetti and Pesenti (2001), Cavallo and Ghironi (2002), Devereux and Engel (2002), Kollmann
(2002), and Smets and Wouthers (2002). However, in the NOEM literature, the standard specification of consumption utility functions remains time separable.

5. In what follows, we mainly focus on the description of the home country because the foreign country is described analogously.


7. Empirical evidence shows that the degree of habit formation ($\gamma$) is about 0.8 to 0.9 (see, for example, Fuhrer (2000)).

8. Empirical evidence shows that the coefficients of relative risk aversion in most developed countries are above 10 (see, for example, Campbell (1999)). In addition, Fuhrer (2000) provided empirical evidence that $\gamma$ is much larger than one. Furthermore, Fuhrer and Klein assumed that $\gamma = 6.1$ for the model with habit formation to generate the observed positive international consumption correlations.

9. Fuhrer (2000) attempted to provide a justification for this assumption $h_t = C_{t-1}$ by testing for it empirically, using GMM and FIML estimates. As a result, he obtained strong evidence regarding $h_t = C_{t-1}$. In addition, Fuhrer and Klein (1998) obtained empirical evidence on the presence of habit formation characterized by $h_t = C_{t-1}$ by using quarterly time series data for Canada, Germany, Italy, the United Kingdom, and the United States. For the fuller formulation of habits, see, for example, Carroll (2000) and Fuhrer (2000), in which the formulation of habits is defined as $Z_t = \rho Z_{t-1} + (1-\rho)C_{t-1}$, where $Z_t$ is the level of habits and $0 \leq \rho \leq 1$ is the parameter measuring the persistence of the level of habits.

10. Obstfeld and Rogoff (1995) used the logarithmic form of the utility function.

11. We have used the index $h$ to denote the symmetric values within the home country, and have used the index $f$ for the foreign country.

12. For brevity we consider only the effects of expansionary monetary shocks. The results could be readily extended to other shocks, e.g., government spending and productivity shocks.

13. The MM and GG schedule are the same as that in Obstfeld and Rogoff’s model when $\kappa = 0$, but they differ when $\kappa > 0$.

14. In related work, by introducing habit formation in consumption into the Sidrauski (1967) model, Faria (2001) showed that the steady-state money demand in his model is larger than that of the benchmark model of Sidrauski (1967).
References


Figure 1. Monetary Policy Shock