Kiel Institute for World Economics
Duesternbrooker Weg 120
24105 Kiel (Germany)

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Exchange Rate Expectations Redux and Monetary Policy

by

Christian Pierdzioch

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Abstract

This paper uses a dynamic general equilibrium optimizing two-country model to analyze how the formation of exchange rate expectations shapes the effects of monetary policy shocks in open economies. The model implies that the short-run output effects of permanent monetary policy shocks diminish if 'noise traders' in the foreign exchange market form regressive exchange rate expectations. If the influence of these noise traders is strong enough, a permanent expansionary monetary policy shock can result in a temporary decline of the output in the country in which it takes place. The output effects of temporary monetary policy shocks are magnified when noise traders form regressive exchange rate expectations.

Keywords: Monetary policy; Exchange rate expectations; Noise trading

JEL classification: F31, F41, G15

Dr. Christian Pierdzioch
Kiel Institute for World Economics
24100 Kiel, Germany
Telephone: +49-431-8814-269
Fax: +49-431-8814-525
E-mail: c.pierdzioch@ifw.uni-kiel.de

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1. Introduction

The analysis of the effects of monetary policy in open economies has a long tradition in the international finance and macroeconomics literature. In the last three decades, monetary policy analyses have often been undertaken by resorting to the classic models of Fleming (1962) and Mundell (1963). In its basic textbook form, the Mundell-Fleming model implies that, in a flexible exchange rate system and with integrated international financial markets, a permanent monetary expansion brings about a depreciation of the exchange rate. The depreciation of the exchange rate, in turn, leads to a capital outflow, improves the trade balance, and eventually leads to an increase in income and employment. Hence, a key result of the model is that, as measured in terms of its effects on output, monetary policy is most effective under flexible exchange rates with perfect international capital mobility.

When drawing policy conclusions from the Mundell-Fleming model, one has to bring to mind that the implications of this model for the effects of monetary policy in open economies hinge upon a number of crucial assumptions. One important assumption is that exchange rate expectations are static. Dornbusch (1976a) showed that relaxing this restrictive assumption can significantly alter the implications of the Mundell-Fleming model for the effects of monetary policy in open economies. To demonstrate the importance of exchange rate expectations, he assumed that agents form regressive exchange rate expectations, i.e., agents expect that the exchange rate will reverse its direction of change and will move back to a long run target value. He showed that extending the Mundell-Fleming model to incorporate this assumption implies that the short run output effect of an unanticipated permanent monetary expansion falls short of that in the baseline Mundell-Fleming model (see also Argy and Porter (1972)).

A similar result drops out of the classic sticky price 'overshooting' model considered by Dornbusch (1976b). As the traditional Mundell-Fleming model, this model implies that the short run output effect of a permanent monetary policy shock is decreasing in the elasticity of economic agents' regressive exchange rate expectations with respect to deviations of the actual exchange rate from its long run target value. With aggregate demand being a function of the real exchange rate, this result obtains if the monetary policy shock implies that the nominal exchange rate 'overshoots' its long run target value in the short run.

In this paper, I use a modern stochastic dynamic optimizing 'new open economy macro' (NOEM) model of the type developed by Obstfeld and Rogoff (1995) to reconsider the implications of exchange rate expectations for the effects of monetary policy in open economies. The major advantage of using a NOEM model to reassess the implications of exchange rate expectations for monetary policy is that NOEM models are full-fledged micro-founded general equilibrium models. NOEM models, therefore, allow taking into account the intertemporal budget constraints and the dynamic optimization of the private sector when analyzing the effects of monetary policy shocks in open economies. In addition, these models are inherently dynamic and, thus, render it possible to take into consideration that monetary policy shocks induce a long-run adjustment process driven by changes in the stock of foreign asset holdings of the private sector. Furthermore, because the NOEM model developed in this paper is a model describing a two-country world, it makes it possible to capture the international feedback effects of national monetary policies.

The 'prototype' NOEM model developed by Obstfeld and Rogoff (1995) is built on the assumption that foreign exchange markets work completely efficient. It can, therefore, not be employed to study how the effects of macroeconomic policies depend upon the alternative techniques agents may use to form their exchange rate expectations. To study in detail the impact of the formation of exchange rate expectations on the macroeconomic effects of a monetary policy shock, I extend the widely used Obstfeld-Rogoff model by allowing for the type of small deviations from rational expectations discussed in the large and substantial ‘noise trader’ literature. Noise traders are financial market participants whose demand for a financial security is not influenced by economic fundamentals alone (Black (1986)). Noise traders employ techniques provided by, for example, technical chart analysis to forecast exchange rate movements. The empirical relevance of such deviations from rational expectations has been documented in a number of studies of the exchange rate forecasting techniques used by foreign exchange traders (see, e.g., Allen and Taylor (1990), Frankel and Froot (1987a,b), Ito (1994), Menkhoff (1997)). In light of this evidence, I follow Da Silva (2001) and Devereux and Engel (2002) and extend the Obstfeld-Rogoff model to incorporate noise-trader generated deviations from rational expectations in the foreign exchange market.

Paralleling the results reported in the contributions of Dornbusch (1976a,b), I find that if noise traders form regressive exchange rate expectations the short run output effect of an unanticipated permanent monetary policy shock decreases. Thus, though the details of the macro-dynamic adjustment process triggered by a monetary policy shock are different, the results derived for the Mundell-Fleming-Dornbusch model in principle also hold if one uses a modern micro-founded dynamic NOEM model to study the output effects of monetary policy in open economies.

Yet, I also find that this result has to be qualified in two important dimensions. First, I find that if the influence of noise traders forming regressive exchange rate expectations is strong enough, an unanticipated permanent expansionary monetary policy shock can result in a decline of output in the country in which it takes place. Numerical simulations of the model show that output tends to decline if such a monetary policy shock gives rise to a deterioration of the trade balance and, thus, to a decline in the stock of foreign bond holdings of the private sector. Second, I find that the short run output effect of an unanticipated temporary monetary policy shock is magnified if noise traders in the foreign exchange market form regressive exchange rate expectations. Thus, the NOEM model developed in this paper implies that the persistence of monetary policy shocks deserves special attention when analyzing how the formation of exchange rate expectations shapes the effects of monetary policy in open economies.

The remainder of the paper is organized as follows. In Section 2, I lay out the theoretical model I use to derive the main results of this paper. In Section 3, I use impulse response functions to analyze how the dynamic macroeconomic effects of a monetary policy shock depend upon the formation of exchange rate expectations in the foreign exchange market. Section 4 concludes.

2. The Model

The world is made up of two countries, Home and Foreign. Each country is inhabited by infinitely-lived identical households. The households seek to maximize their expected lifetime utility. In addition, each country is populated by a continuum of profit maximizing firms. Each countries' households own the respective domestic firms. The firms sell differentiated products in a monopolistically competitive goods market. When changing the price of their product, firms incur menu costs, implying that prices are sticky. The only production factor used by the firms is labor. The firms hire labor in a perfectly competitive labor market. Labor is immobile internationally.

The special feature of the model is the structure of financial markets. The structure of financial markets is such that Foreign households only hold Foreign currency denominated bonds. Home households, in contrast, hold both Home and Foreign currency denominated bonds. While they can directly trade in Home currency denominated bonds, all trading of Home households in Foreign currency denominated bonds is, as in Devereux and Engel (2002), carried out by specialized foreign exchange dealers. Foreign exchange dealers act in a competitive market and seek to maximize the discounted expected returns of buying and selling Foreign currency denominated bonds. To form exchange rate expectations, foreign exchange dealers conduct a questionnaire among foreign exchange rate forecasters. Some of these foreign exchange rate forecasters are 'noise traders' who use a technical forecasting rule to compute exchange rate forecasts.

2.1 Households' Preferences and Goods Market Structure

Home and Foreign households have identical preferences and seek to maximize the present value of their expected lifetime utility. The expected lifetime utility of a Home household is defined as:

$$U_t = E_t \sum_{s=t}^{\infty} \beta^{s-t} \left(\log(C_s) + \chi \log(M_s / P_s) - N_s^{\mu} / \mu \right), \tag{1}$$

where $\mu > 1, \chi > 0$, $0 < \beta < 1$ and E_t denotes the conditional expectations operator. In Eq. (1), C_t denotes a real consumption index, N_t is the households' labor supply, and M_t / P_t denotes the end-of-period real money holdings, where M_t is the supply of Home outside money and P_t is the aggregate Home price index defined below. Households hold only the money issued by the central bank of the country in which they reside, i.e., there is no currency substitution.

The aggregate consumption index, C_t, is defined as a CES aggregate over a continuum of differentiated, perishable Home and Foreign consumption goods of total measure unity. These goods are sold by Home and Foreign firms in a monopolistically competitive goods market and are indexed by z on the unit interval, so that the aggregate consumption index can be expressed as:

$$C_t = \left[\int_0^1 c_t(z)^{(\theta-1)/\theta} dz \right]^{(\theta-1)/\theta}, \tag{2}$$

where $\theta > 1$ and $c(z)$ denotes consumption of good z.

The Home price deflator for nominal money balances, P_t, is defined as the minimum expenditure required to buy one unit of the aggregate consumption index, C_t. Assuming that the law-of-one-price holds for each differentiated good and denoting the domestic currency price of good z by $p_t(z)$, this price deflator is given as:

$$P_t = \left[\int_0^1 p_t(z)^{1-\theta} dz \right]^{1/(1-\theta)} = \left[\int_0^n p_t(z)^{1-\theta} dz + \int_n^1 \{S_t p_t^*(z)\}^{1-\theta} dz \right]^{1/(1-\theta)}, \tag{3}$$

where n $(1-n)$ is the number of differentiated goods made at home (abroad), S_t denotes the nominal exchange rate defined as the amount of Home currency units required to buy one unit of the Foreign currency, and $p_t^*(z)$ denotes the Foreign currency price of a differentiated product produced abroad. Here and in the following, an asterisk denotes a Foreign variable. With identical preferences at home and abroad and the law-of-one-price holding for each differentiated good, it immediately follows that purchasing power parity holds: $P_t = S_t P_t^*$, where P_t^* denotes the aggregate Foreign price index. The Foreign price index is given by a formula similar to that given in Eq. (3).

2.2 Households' Budget Constraint and Individual Maximization

In addition to real balances, Home and Foreign households hold nominal bonds. Whereas Foreign households only hold Foreign currency denominated bonds, Home households can take positions in both Home and Foreign currency denominated bonds. While they can directly buy and sell Home currency denominated bonds, they have to contact a specialized foreign exchange dealer to invest in the international financial market. Foreign exchange dealers act in the interest of Home households. Each period, Home households receive from the foreign exchange dealer a net payment of Π_t^f, denominated in Home currency units, for their investment account. Households take the net payment they receive from the foreign exchange dealer as given. Depending on the trading performance of the foreign exchange dealer, this net payment may be negative or positive:

$$\Pi_t^f = S_t B_{h,t-1}^* - d_t^* S_t B_{h,t}^* , \tag{4}$$

where $B_{h,t}^*$ denotes Home foreign exchange dealers' holdings of Foreign currency denominated bonds paying one unit of foreign currency in period $t+1$ and d_t^* is the period t price of Foreign currency denominated bonds. The first term on the right-hand side of Eq. (4) denotes the amount Households receive in period t from the foreign exchange dealer. The second term on the right-hand side of Eq. (4) gives the new payments Households make in period t to the foreign exchange dealer.

Total income received by Home households consists of the yield on their holdings of Home bonds, the net payment, Π_t^f, they receive from their foreign exchange dealer, the profit income for the ownership of Home firms (i.e., dividend income), and the labor income. Given total income, households determine their optimal consumption, decide on their preferred Home bond holdings, and determine their preferred holding of domestic outside money. In addition, they receive transfers from the government. Home households, therefore, face the following flow budget constraint:

$$P_t C_t + d_t B_t + M_t = B_{t-1} + M_{t-1} + w_t N_t + \Pi_t + \Pi_t^f + P_t T_t , \tag{5}$$

where B_t stands for the quantity of Home currency denominated nominal bonds paying out one unit of Home currency in period $t+1$, d_t denotes the period t price of these bonds, T_t stands for real lump-sum transfers (denominated in terms of the consumption aggregate, C_t), w_t is the nominal wage rate earned in a perfectly competitive domestic labor market, and Π_t denotes the nominal profit income the household receives from domestic firms.

The flow budget constraint for a Foreign household can be derived in an analogous way:

$$P_t^* C_t^* + d_t^* B_{f,t}^* + M_t^* = B_{f,t-1}^* + M_{t-1}^* + w_t^* N_t^* + \Pi_t^* + P_t^* T_t^* , \tag{6}$$

where $B_{f,t}^*$ denotes the Foreign households' holdings of Foreign currency denominated bonds.

The first-order conditions for the Home households' intertemporal optimization problem are:

$$1/C_t = \lambda_t P_t , \tag{7}$$

$$\chi / M_t + \beta E_t(\lambda_{t+1}) = \lambda_t , \tag{8}$$

$$N^{\mu-1} = \lambda_t w_t , \tag{9}$$

$$(1+R_t)\beta E_t(\lambda_{t+1}) = \lambda_t , \tag{10}$$

$$\beta E_t \lambda_{t+1} = \lambda_t d_t , \tag{11}$$

where λ_t denotes the Lagrange multiplier. In addition, the usual transversality condition applies. Analogous first-order conditions can be derived for Foreign households.

2.3 Foreign Exchange Dealers

As in Devereux and Engel (2002), Foreign exchange dealers act in a competitive market and seek to maximize the discounted expected returns of buying and selling Foreign currency denominated bonds:

$$\max E_t^{fx}\left(d_t S_{t+1} B_{h,t}^* - d_t^* S_t B_{h,t}^*\right), \tag{12}$$

where E_t^{fx} denotes foreign exchange dealers profit expectations and d_t is the state contingent value of domestic currency delivered in period $t+1$. Because foreign exchange dealers act in a competitive market, Eq. (12) is a zero-expected-profit condition that can be used to derive the following no-arbitrage condition of uncovered interest rate parity:

$$d_t^* = E_t^{fx}[d_t S_{t+1} / S_t] . \tag{13}$$

To form exchange rate expectations, foreign exchange dealers conduct a questionnaire among foreign exchange rate forecasters. The foreign exchange rate forecasters can be subdivided into a group of 'noise traders' and a group of 'fundamentalists' using economic fundamentals to form exchange rate expectations.

Letting a variable with a hat denote percentage deviation from the steady state, I assume that the exchange rate forecasts of noise traders are given by:

$$E_t^n(\hat{S}_{t+1} - \hat{S}_t) = -\phi(\hat{S}_t - \hat{S}_t^T) , \tag{14}$$

where ϕ denotes the elasticity of noise traders' expectations with respect to the deviation of the actual exchange rate change from a medium-term exchange rate target, $\hat{S}_t^T$. Similar representations of noise traders' expectations formation have often been used in the noise trader literature. Though mathematically more complex forecasting rules for the expectations formation of noise traders could, of course, be analyzed, the discussion in Section 3 will show that the simple technical forecasting rule given in Eq. (14) suffices to illustrate the main result of this paper.

Noise traders calculate the medium-term exchange rate target, $\hat{S}_t^T$, as the geometrically-weighted moving average of the exchange rates observed during the last $ma > 0$ periods:

$$\hat{S}_t^T = \sum_{j=1}^{ma} \big((ma + 1 - j)/J\big)\hat{S}_{t-j} , \quad \text{with} \quad J = \sum_{j=1}^{ma} j \tag{15}$$

Eqs. (14) and (15) stipulate that noise traders compare the actual exchange rate with the moving average of the exchange rate when forming their exchange rate forecasts and, thus, behave as chartists. When $\phi < 0$, noise traders extrapolate the most recent exchange rate change. When $\phi > 0$, in contrast, noise traders expect that the currently observed exchange rate movement will be reversed in period $t+1$ and, thus, form regressive expectations. This type of regressive expectations is similar to the type of regressive expectations analyzed by Dornbusch (1976a,b).

The empirical evidence reported in the noise trader literature suggests that exchange rate forecasters form regressive rather than extrapolative exchange rate expectations at forecasting horizons of several months (see Frankel and Froot (1987a,b, 1990), Ito (1994), and Menkhoff (1997), just to name a few). Because such forecasting horizons seem to be the most relevant ones for business cycle analyses, I will focus on the case $\phi > 0$ when reporting the results of numerical simulations of the model in Section 3 below.

As regards the behavior of fundamentalists, I assume that these foreign exchange rate forecasters use economic fundamentals to form their exchange rate forecasts. They form model consistent, rational exchange rate forecasts:

$$E_t^f(\hat{S}_{t+1} - \hat{S}_t) = E_t(\hat{S}_{t+1} - \hat{S}_t) , \tag{16}$$

Foreign exchange dealers compute a weighted average of the exchange rate forecasts of noise traders and fundamentalists to form their exchange rate expectations:

$$E_t^{fx}(\hat{S}_{t+1}-\hat{S}_t) = gE_t^n(\hat{S}_{t+1}-\hat{S}_t) + (1-g)E_t^f(\hat{S}_{t+1}-\hat{S}_t), \qquad (17)$$

where $g \in [0,1]$ denotes the weight given to noise traders. When $g = 0$, foreign exchange dealers form rational expectations and the model becomes a close variant of the model developed by Obstfeld and Rogoff (1995).

2.4 Firms

Each profit-maximizing Home firm hires labor to produce a differentiated good indexed by z according to the production function $y_t(z) = N_t(z)$. The firm's nominal profits are, thus, given by $\Pi_t(z) = p_t(z)y_t(z) - w_t y_t(z)$. Because each firm has monopoly power on the market for the differentiated good it produces, it treats the price, $p_t(z)$, it charges for its product as a choice variable and seeks to set the price of its product to maximize profits. When setting the price of its product, the firm faces the following demand curve for its good in the monopolistically competitive goods market:

$$y_t(z) = (p_t(z)/P_t)^{-\theta} Q_t, \qquad (18)$$

where $Q_t = (nC_t + (1-n)C_t^*)$ is the aggregate world-demand function.

When setting prices, firms have to take into account that they are subject to sluggish price adjustment of the form described in Calvo (1983). According to this price adjustment mechanism each firm has to take into account when setting its profit-maximizing price that there is a positive probability $0 < \gamma < 1$ that it cannot revise its price setting decision made in period $s < t$ in period t. Firms, therefore, set the current price of their product, $p_t(z)$, so as to maximize the expected present value, $V_t(z)$, of current and future real profits, where period s, $s > t$, profits are weighted by the probability that the current period price, $p_t(z)$, will still be in force in period s. As in Sutherland (1996), firms maximize:

$$\max_{p_t(z)} V_t(z) = E_t \sum_{s=t}^{\infty} \gamma^{s-t} R_{t,s} \Pi_s(z) / P_s \,, \tag{19}$$

where $R_{t,s} \equiv \Pi_{j=s}^{t} d_j$ is the discount factor for period $s > t$ expected real profits. Eq. (18) shows that the sluggish price adjustment makes each firms' price setting problem dynamic; rather than maximizing its profits period-by-period, each firm acts to maximize its total market value. Using Eq. (18) in Eq. (19), the profit-maximizing price can expressed as:

$$p_t(z) = \left(\frac{\theta}{\theta-1}\right) \frac{E_t \sum_{s=t}^{\infty} \gamma^{s-t} R_{t,s} (Q_s / P_s)(1/P_s)^{-\theta} w_s}{E_t \sum_{s=t}^{\infty} \gamma^{s-t} R_{t,s} (Q_s / P_s)(1/P_s)^{-\theta}} \tag{20}$$

An analogous expression can be derived for the profit-maximizing Foreign currency price, $p_t^*(z)$, set by Foreign firms.

2.5 The Government Sector

The Home and Foreign governments do not purchase consumption goods. This implies that they finance real transfers by seignorage. The period-budget constraint for the Home government can, thus, be written as:

$$T_t = (M_t - M_{t-1}) / P_t \tag{21}$$

The Home money supply evolves according to the following stochastic difference equation:

$$\hat{M}_t = \alpha \hat{M}_{t-1} + \varepsilon_{M,t}, \tag{22}$$

where $\varepsilon_{M,t}$ is a serially uncorrelated stochastic disturbance term and the parameter $\alpha \in [0,1]$ governs the persistence of the money supply process. Analogous equation hold for the Foreign government.

2.6 Definition of Equilibrium and Model Solution

In a symmetric monopolistic competition equilibrium in the world economy, output, consumption, the exchange rate, prices, interest rates and wage rates, Home and Foreign bond holdings follow stochastic processes such that (i) the labor market in each country clears, (ii) the optimality conditions for consumption and asset holdings are satisfied, (iii) the intertemporal budget constraint for each country is satisfied, (iv) the markets for Home and Foreign bonds are in equilibrium, (v) firms set prices according to Eq. (20), (vi) the expected profits of foreign exchange dealers are zero, and, (vii) central banks' policies satisfy Eq. (22) and its Foreign counterpart, respectively.

— Insert Table 1 about here.—

To solve the model, I follow Obstfeld and Rogoff (1995) and log-linearize the model around a symmetric flexible-price steady state in which the Home foreign asset position is zero. I then use the algorithm developed by Klein (2000) to numerically simulate the calibrated log-linearized model. The calibration of the model is given in Table 1.

3. Exchange Rate Expectations and Monetary Policy

In this section, I use impulse response functions to visualize the implications of noise trading for the impact of monetary policy shocks on key Home and Foreign variables. To compute the impulse responses, I follow Sutherland (1996) in assuming that the Home and Foreign money supply shocks are perfectly negatively correlated, i.e., monetary policy shocks are asymmetric.

I begin with the analysis of the effects of an unanticipated permanent monetary policy shock. This is the type of shock analyzed by Dornbusch (1976a,b). I then present impulse response functions depicting how noise trading changes the output effects of an unanticipated temporary monetary policy shock. At the end of this section, I compare the results of the numerical simulations of the NOEM model laid out in Section 2 with the results of Dornbusch's (1976a,b) analysis of the traditional Mundell-Fleming and the classic 'overshooting' model.

3.1 The Effects of a Permanent Monetary Policy Shock

The impulse response functions depicted in Figure 1 summarize the impact of an unanticipated permanent monetary policy shock on key Home variables. I assume that the monetary policy shock is asymmetric: the Home money supply increases and the Foreign money supply decreases by an equal amount. Because of the asymmetry of the shock, the dynamic macroeconomic adjustment process taking place in the Foreign economy is a mirror image of the macroeconomic adjustment process observed in the Home economy and is, therefore, not shown in Figure 1.

In Figure 1, solid lines denote the impulse response functions for a model in which all foreign exchange rate forecasters form rational expectations ($g = 0$). In this model, capital tends to flow from the Home to the Foreign economy to achieve money market equilibrium. As can be seen in Figure 1, this capital outflow from the Home economy does not affect the nominal interest rates. This shows that the Home demand for Foreign currency denominated nominal bonds is equal to the supply of Foreign currency denominated nominal bonds by Foreign households.

While leaving the nominal interest rate unaffected, the impulse response function for consumption reveals that the monetary policy shock results in a change of the real interest rates. The time-profile of the Home consumption path shows that the rise in expected inflation brought about by the Home monetary expansion results in a decline in the Home real interest rate. Because the decline in the real interest rate raises the expected present value of future consumption, Home households try to smooth consumption by increasing current consumption spending. Foreign households, in contrast, decrease their consumption spending because the Foreign real interest rate has increased.

Though this implies that the relative demand for Home currency increases, this effect is not strong not enough to outweigh the increase in the relative supply of Home currency brought about by the asymmetric monetary policy shock. The increase in the relative supply of Home currency, therefore, leads to a depreciation of the nominal exchange rate. The nominal depreciation, in turn, leads to a real depreciation of the Home currency, where the real exchange rate is defined as the relative price of Home differentiated goods in terms of Foreign differentiated goods. The real depreciation of the Home currency makes Foreign goods more expensive relative to Home goods. In consequence, the supply of Home goods increases while the supply of Foreign goods decreases.

Comparing the time-profile of the Home consumption path with the time-profile of the Home output path, it follows that the real depreciation improves the trade balance, implying that the Home economy starts to accumulate Foreign bonds. Because this accumulation of Foreign currency denominated bonds increases the wealth of Home households, Home consumption jumps to a higher new steady state equilibrium level while Home output settles below its initial steady state equilibrium level (see also Obstfeld and Rogoff (1995)).

— Insert Figure 1 about here.—

Now I consider an economy in which some foreign exchange rate forecasters are noise traders. To this end, I assume that the weight foreign exchange dealers give to this group of foreign exchange rate forecasters when forming their exchange rate expectations is relatively small ($g = 0.3$). In this case, the initial nominal depreciation taking place in the aftermath of a permanent monetary policy shock implies that the noise traders form appreciation expectations. However, because the Home demand for Foreign currency denominated bonds is equal to the supply of Foreign currency denominated bonds by Foreign households, this does not imply that the international nominal interest rate differential becomes negative. Rather, the foreign exchange rate forecasters belonging to the group of fundamentalists now form rational depreciation expectations. This, in turn, implies that the nominal depreciation of the Home currency triggered by the monetary policy shock is smaller than in a world in which all foreign exchange forecasters form rational exchange rate expectations.

This response of the exchange rate is consistent with the time-profile of consumption. Figure 1 shows that the response of consumption to a permanent monetary shock is stronger if some foreign exchange rate forecasters form regressive exchange rate expectations. This strong response of consumption, in turn, implies that the increase of the relative demand for the Home currency is also stronger if some noise traders form regressive exchange rate expectations. In consequence, the depreciation of the exchange rate triggered by the permanent monetary policy shock is smaller in the model in which some forecasters are noise traders than in the model in which all foreign exchange rate forecasters form rational expectations. Because of this dampening effect on the exchange rate response to a monetary policy shock, the expansionary (contractionary) effect of the monetary policy shock on Home (Foreign) output will be less pronounced in the presence noise traders providing foreign exchange traders with regressive exchange rate forecasts.

To compute the impulse responses depicted in Figure 1, I assumed that the influence of noise traders on the exchange rate expectations of foreign exchange dealers is moderate. I now analyze how the dynamics of the model change when the noise traders exert a relatively strong influence on the exchange rate expectations of foreign exchange dealers. To this end, I increase the weight foreign exchange dealers give to noise traders to $g = 0.6$.[1] The impulse responses corresponding to this case are given in Figure 2.

— Insert Figure 2 about here.—

Figure 2 shows that Home output can decrease temporarily in the aftermath of a permanent monetary policy shock if the influence of noise traders on the formation of exchange rate expectations is strong enough. As can be seen in the figure, the strong influence of the noise traders on the formation of exchange rate expectations of foreign exchange dealers implies that the monetary policy shock results in a temporary real appreciation rather than a real depreciation of the Home currency. The Home currency

[1] If the weight given by foreign exchange dealers to noise traders and/or the elasticity of noise traders' exchange rate expectations with respect to exchange rate movements are very large, the model may exhibit unstable dynamics. All calibrations of the model presented in this paper yield stable model solutions.

appreciates in real terms because the nominal depreciation triggered by the monetary policy shock is not large enough to compensate the beginning rise (fall) of Home (Foreign) goods prices. Because the trade balance shows a 'normal' reaction to real exchange rate changes, the real appreciation of the Home currency goes in line with a deterioration of the trade balance. This deterioration of the trade balance implies that the Foreign bond holdings of the Home economy start to decline.

The real appreciation of the Home currency further implies that the permanent expansionary Home monetary policy shock results in a temporary decline of Home output. In the long-run, however, Home output reaches a level above its initial steady state level. The reason is that the loss of Foreign bonds triggered by the monetary policy shock implies that the wealth of Home households declines. Facing this loss of wealth, Home agents start to increase in the long run their work effort and to decrease consumption spending.

3.2 The Effects of a Temporary Monetary Policy Shock

Figure 3 depicts impulse response functions summarizing the macro-dynamic effects of an unanticipated asymmetric temporary monetary policy shock. The figure reveals that the presence of noise traders forming regressive exchange rate expectations magnifies the short run output effects of a temporary monetary policy shock.

— Insert Figure 3 about here.—

Because the monetary policy shock is temporary, the impact of the shock term on the money supply will be gradually reversed until the money supply reaches its pre-shock level. This, in turn, implies that the nominal and real depreciation of the Home currency taking place in the immediate aftermath of the temporary monetary policy shock will also be gradually reversed in the time periods following the shock. This reversal of the initial depreciation of the Home currency implies that both noise traders and fundamentalists form appreciation expectations.

Increasing the number of noise traders means that foreign exchange dealers attach a smaller weight to the appreciation expectations of fundamentalists. This, in turn, implies that the initial depreciation of the Home currency is larger and the rate at which the nominal exchange reaches its new steady state is smaller the larger is the number of noise traders forming regressive exchange rate expectations.

It is worth noting that Figure 3 indicates that the negative expected rate of Home inflation reflecting the expected decline of the Home money supply results in a temporary increase in the Home real interest if foreign exchange dealers attach a positive weight to noise traders when forming their exchange rate expectations. The temporary increase in the Home real interest rate, in turn, induces Home households to decrease their consumption spending. The resulting decline in the relative demand for Home currency justifies the relatively strong depreciation of the nominal exchange rate taking place if foreign exchange dealers take into account the exchange rate forecasts of noise traders.

Because prices are sticky, the nominal depreciation translates into a real depreciation of the Home currency, resulting in a rise of Home output. Because the response of the real exchange rate to a temporary monetary policy shock is larger in a model in which some foreign exchange forecasters form regressive exchange rate expectations, the output effect of this a shock is also larger in such a model.

3.3 Comparing the NOEM View with the Mundell-Fleming-Dornbusch View

It is interesting to compare the results of the analysis of the NOEM model developed in this paper with the results of Dornbusch's (1976a,b) analysis of the Mundell-Fleming and the 'overshooting' model. Confirming the results reported by Argy and Porter (1972), Dornbusch finds that the presence of traders forming regressive exchange rate expectations dampens the short-run output effects of an expansionary unanticipated permanent monetary policy shock. Figure 1 reveals that a similar result drops out of the NOEM model laid out in this paper.

However, as can be seen in Figure 2, there is also an important difference between the implications of the Mundell-Fleming-Dornbusch model and the implications of the NOEM model analyzed in this paper. In the models analyzed by Dornbusch (1976a,b), the presence of traders forming regressive exchange rate expectations only *dampens* the expansionary short-run output effect of an expansionary unanticipated permanent monetary policy shock. In contrast, as shown in Figure 2, such a shock can result in a temporary *decline* of output in the NOEM model analyzed in this paper. This tends to be the case of the influence of noise traders forming regressive exchange rate expectations on the behavior of foreign exchange dealers is relatively strong. In the type of Mundell-Fleming model analyzed by Dornbusch (1976a), monetary policy can only result in a temporary decline of output if a real depreciation of the Home currency does not raise the demand for domestic output (Niehans (1975)).

Another interesting implication of the NOEM model analyzed in this paper is that the short run output effect of an unanticipated temporary monetary policy shock is magnified if noise traders form regressive exchange rate expectations. This result reveals that the implications of exchange rate expectations for the effects of monetary policy in open economies depend on the persistence of monetary policy shocks.

Furthermore, in Dornbusch's (1976a) version of the Mundell-Fleming model, the presence of foreign exchange dealers forming regressive exchange rate expectations implies that the short-run response of the nominal exchange rate to an unanticipated permanent monetary policy shock is larger than its long-run response to such a shock. Regressive exchange rate expectations, thus, give rise to an 'overshooting' of the nominal exchange rate. This effect also occurs (though not necessarily) in the 'overshooting' model developed by Dornbusch (1976b). In the NOEM model discussed in this paper, in contrast, the nominal exchange rate tends to 'undershoot' if noise traders form regressive exchange rate expectations. This result drops out of the model because, for uncovered interest rate parity to hold, the exchange rate expectations of noise traders must be matched by the exchange rate expectations of the fundamentalists. Because the nominal depreciation of the Home currency that takes place in the aftermath of an unanticipated permanent monetary policy shock induces noise traders to form regressive appreciation expectations, fundamentalists form equally strong rational depreciation expectations. These rational depreciation expectations, in turn, require that the short-run response of the nominal exchange rate to a permanent monetary policy shock falls short of its long-run response to such a shock.

It is also noteworthy that in the Mundell-Fleming-Dornbusch model the long run effects of a permanent monetary policy shock do not depend on the way in which agents form their exchange rate expectations. In consequence, the techniques used by economic agents to forecast exchange rate movements do not impinge back on the level of output realized in the post-shock steady-state equilibrium. In the NOEM model developed in this paper, in contrast, the impact of noise trading on the short-run macro-dynamic adjustment process triggered by a monetary policy shock has consequences for the long run steady-state equilibrium to which the model converges. The reason is that the steady-state equilibrium of the NOEM model analyzed in this paper is a function of the long run Foreign bond holdings of the Home economy. Noise trading has implications for the long-run Foreign bonds holdings of the Home economy because it changes the short-run response of the trade balance to a monetary policy shock. Because the response of the trade balance determines the long run Foreign bond holdings of the Home economy, allowing for noise trading in the foreign exchange market changes the steady state to which the model converges in the aftermath of a monetary policy shock.

4. Conclusions

In recent years, resorting to the class of so called NOEM models in the tradition of the model developed by Obstfeld and Rogoff (1995) has become a popular way of analyzing the effects of macroeconomic policies in open economies. The approach taken in the NOEM literature differs radically from that of the traditional Mundell-Fleming-Dornbusch model in that it allows policy issues to be analyzed by means of full-fledged micro-founded dynamic general equilibrium models.

The NOEM model I analyzed in this paper has in common with the Mundell-Fleming-Dornbusch model that the presence of noise traders forming regressive exchange rate expectations can diminish the short-run output effects of an unanticipated permanent monetary policy shock. This result shows that, as in the Mundell-Fleming-Dornbusch model, the techniques used by foreign exchange market participants to forecast exchange rate movements should be taken into consideration if one uses a modern dynamic micro-founded NOEM model to study the output effects of monetary policy in open economies.

The NOEM model I analyzed in this paper has two interesting additional implications that are not implied by the traditional Mundell-Fleming-Dornbusch model. First, it implies that an unanticipated permanent expansionary monetary policy shock can result in a decline of output if the influence of noise traders forming regressive exchange rate expectations on the behavior of foreign exchange dealers is relatively strong. Second, it implies that the short run output effect of an unanticipated temporary monetary policy shock are magnified if noise traders in the foreign exchange market form regressive exchange rate expectations. These results indicate that the effects of monetary policy in open economies can change over time if the weight given to noise traders is not constant or the persistence of monetary policy shocks changes over time.

In this paper, I focused entirely on the implications of noise trading for the positive effects of monetary policy in open economies. A natural extension of my analysis would be to explore the normative and welfare implications of the model developed in this paper. Because NOEM models feature explicit microeconomic foundations, such welfare analyses have been one of the major applications of this class of models. The model laid out in this paper could be applied to explore how small deviations from rationality in foreign exchange markets affect the welfare effects of monetary policy in open economies. It is left for future research to address this interesting and important question.

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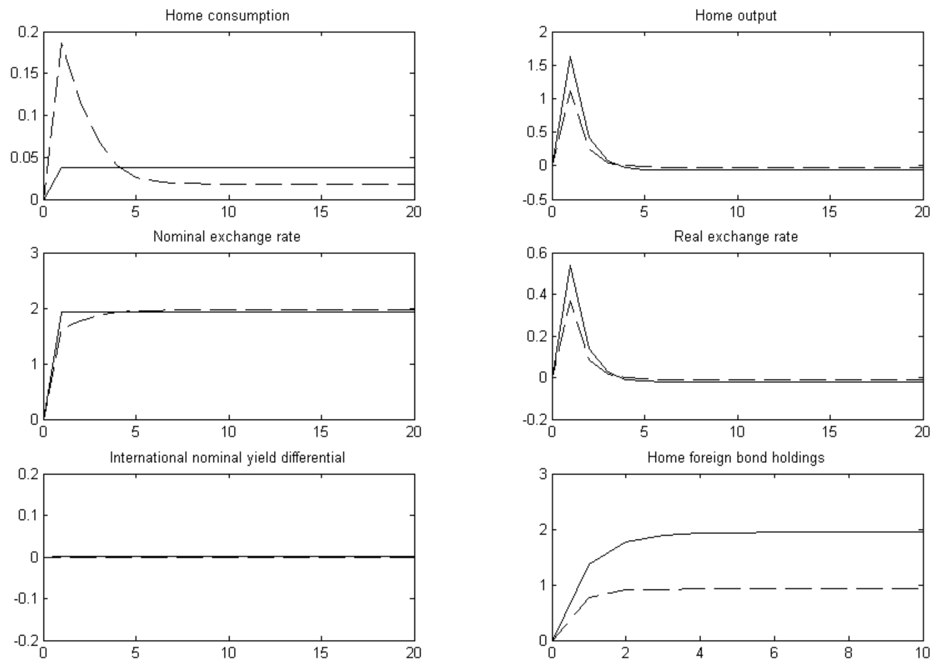
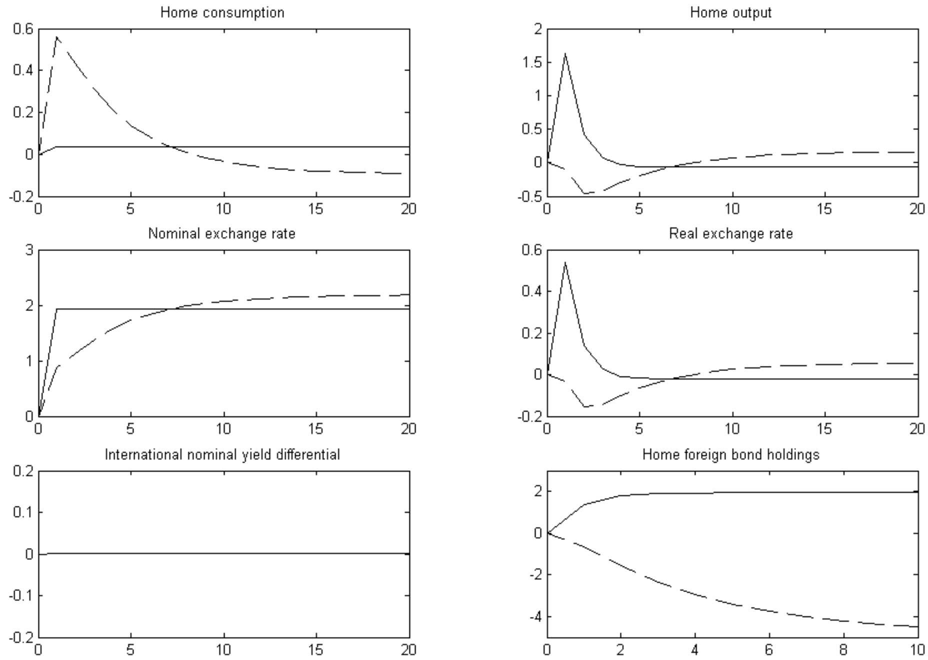
Figures and Tables

Figure 1 – Macroeconomic effects of an unanticipated permanent monetary policy shock ($g = 0.3$)



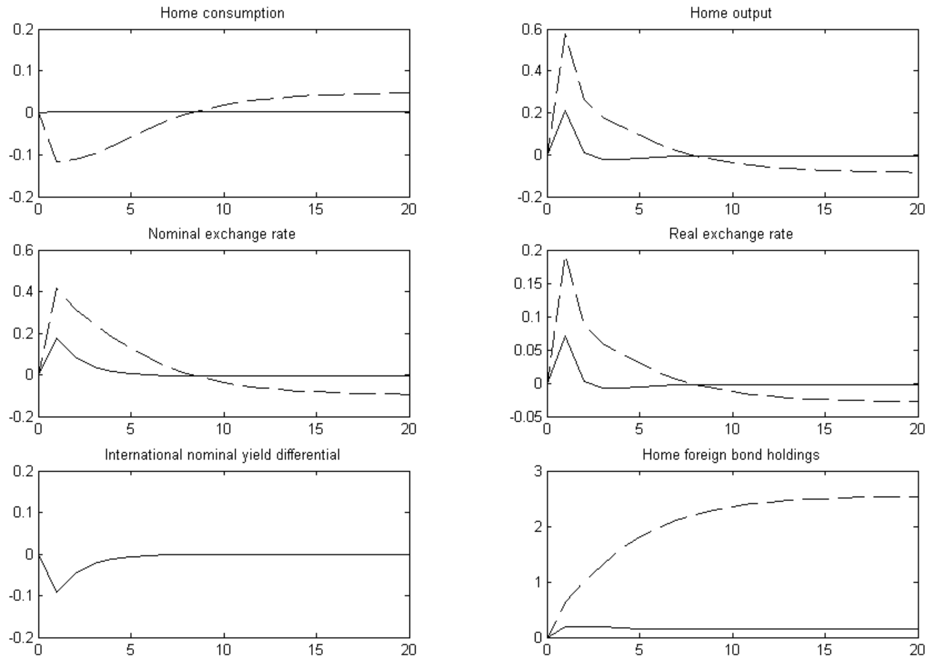
Note: The figure depicts the response of key Home and Foreign variables to an unanticipated, permanent, asymmetric monetary policy shock. Dashed lines obtain when setting $g = 0.3$ and solid lines obtain when setting $g = 0.0$. Consumption, output and the real exchange rate are measured as percentage deviations from the steady state. Bond holdings are measured as percentage deviations from the steady state consumption level.

Figure 2 – Macroeconomic effects of an unanticipated permanent monetary policy shock ($g = 0.6$)



Note: The figure depicts the response of key Home and Foreign variables to an unanticipated, permanent, asymmetric monetary policy shock. Dashed lines obtain when setting $g = 0.6$ and solid lines obtain when setting $g = 0.0$. Consumption, output and the real exchange rate are measured as percentage deviations from the steady state. Bond holdings are measured as percentage deviations from the steady state consumption level.

Figure 3 – Macroeconomic effects of an unanticipated temporary monetary policy shock ($g = 0.6$)



Note: The figure depicts the response of key Home and Foreign variables to an unanticipated, temporary, asymmetric monetary policy shock. The autoregressive coefficients of the Home and Foreign money supply processes assume the numerical value $\alpha = 0.5$. Dashed lines obtain when setting $g = 0.6$ and solid lines obtain when setting $g = 0.0$. Consumption, output and the real exchange rate are measured as percentage deviations from the steady state. Bond holdings are measured as percentage deviations from the steady state consumption level.

Table 1 — The calibrated parameters

Parameter	*Value*	*Description*
β	1/1.05	Subjective discount factor
θ	6.0	Elasticity of substitution between differentiated products
μ	1.4	Labor supply elasticity
ϕ	0.2	Elasticity of noise traders' expectations with respect to exchange rate changes
g	0.6 (0.3)	High (Low) influence of noise traders on foreign exchange traders' expectation formation
α	1 (0.5)	Autoregressive parameter of the money supply process in the case of permanent (temporary) money supply shocks
n	0.5	Country size
J	4	Number of lags used by noise traders to compute the moving average of the exchange rate

Note: The parameters of households' utility function are as in Sutherland (1996). The elasticity of noise traders' expectations with respect to exchange rate changes is in line with the empirical estimates of Frankel and Froot (1987a,b).