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Kiel Working Paper No. 1199

Productivity Shocks and Delayed Exchange-Rate Overshooting

by

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February 2004

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Abstract
This paper uses a 'new open economy macroeconomics' model to study the effect of a productivity shock on exchange rate dynamics. The special features of the model are that households' preferences exhibit a "catching up with the Joneses" effect and that international financial markets are imperfectly integrated. Numerical simulations of the model are used to demonstrate that these features imply that, in an otherwise standard 'new open economy macroeconomics' model, a productivity shock can give rise to a delayed overshooting of the exchange rate.

Keywords: Productivity shock; Exchange rate overshooting

JEL classification: F31, F32, F41

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Acknowledgements:

Financial support by the Fritz-Thyssen-Stiftung is gratefully acknowledged. Serkan Yener provided helpful comments. The usual disclaimer applies.

1. Introduction

What are the consequences of macroeconomic shocks for exchange rate dynamics? Studies of this question have a long tradition in the international macroeconomics literature. In recent years, so called "New Open Economy Macroeconomic" (NOEM) models have been used to reconsider this question. NOEM models trace back to the seminal paper by Obstfeld and Rogoff (1995). Their key idea was to introduce the type of nominal rigidities and market imperfections implicitly assumed in traditional open-economy macroeconomic models into dynamic general equilibrium models with a fully articulated microeconomic foundation. In the recent literature, a number of researchers have taken up this idea, and by now NOEM models have become the standard platform for discussing issues in international macroeconomics.

A prominent issue discussed in the NOEM literature is under which condition macroeconomic shocks can give rise to the type of exchange rate overshooting familiar from the by now classic analysis by Dornbusch (1976). Exchange rate overshooting describes a situation in which the short-run response of the exchange rate to a shock exceeds its long-run response. The interest of researchers in exchange-rate overshooting stems from the fact that it has the potential to strengthen the explanatory power of NOEM models to explain the empirically observed high exchange-rate volatility.

Many researchers have studied whether monetary shocks can imply exchange-rate overshooting in NOEM models. In the prototype NOEM model developed by Obstfeld and Rogoff, the exchange rate does not overshoot in the aftermath of a monetary shock. However, as has been shown by, e.g., Betts and Devereux (2000), Hau (2000), and Warnock (2003), it is straightforward to extend the model developed by Obstfeld and

Rogoff in a way such that it implies that a monetary shock triggers an overshooting of the exchange rate.

While many contributors to the NOEM literature have focused on the implications of a monetary shock for exchange-rate overshooting, Cavallo and Ghironi (2002) have recently emphasized that a productivity shock can also give rise to an overshooting of the exchange rate. Even more important, they have shown that in their model a productivity shock can result in a *delayed* overshooting of the exchange rate. This delayed overshooting of the exchange rate occurs in a situation in which a shock triggers an immediate depreciation of the exchange rate that then, however, gradually continues for some months or quarters before the exchange rate starts moving in the direction of its long-run post-shock level. Delayed overshooting is a phenomenon that has been highly debated in the empirical and theoretical literature on exchange-rate modeling, especially in discussions of the propagation of a monetary shock, (Clarida and Gali 1994, Eichenbaum and Evans 1995; Gourinchas and Tornell 2003, Andersen and Beier 2000). The research by Cavallo and Ghironi implies that delayed exchange-rate overshooting may not only arise in the aftermath of a monetary shock, but also in the aftermath of a productivity shock.

Cavallo and Ghironi report that delayed exchange-rate overshooting arises in their NOEM model because it features an interest-rate rule for monetary policy and an overlapping-generations structure. A productivity shock results in changes in net foreign asset positions, which, however, are gradually reversed in the long run as long as a productivity shock is stationary. The results of the numerical simulations conducted by Cavallo and Ghironi indicate that delayed exchange-rate overshooting arises in the flexible-price version of their NOEM model if a productivity shock is persistent. In the sticky-price version of their NOEM model, a temporary and a persistent productivity shock gives rise to a delayed overshooting of the exchange rate.

The main purpose of the research I lay out in this paper is to show that a productivity shock can trigger a delayed exchange-rate overshooting in a standard NOEM model even if one does not build an interest-rate rule and an overlapping-generations structure into such a model. To show that this is the case, I start from the prototype NOEM model developed by Obstfeld and Rogoff. The NOEM model I develop in this paper differs from their model in two important respects. First, I follow Sutherland (1996), Senay (1998), and Benigno and Thoenissen (2003) in assuming that the markets for internationally traded bonds are imperfectly integrated. Thus, my model features a financial market friction. Second, I assume that households' preferences feature a "catching up with the Joneses" effect. This effect has been extensively studied in the asset-pricing literature. A list of significant contributions to this literature includes the work by Abel (1990), Gali (1994), Campbell and Cochrane (1999), Ljungqvist and Uhlig (2000), and Dupor and Lui (2003), to name just a few. I demonstrate that a productivity shock can give rise to a delayed overshooting of the exchange rate if the Obstfeld-Rogoff model is extended to incorporate both imperfectly integrated international bond markets and a "catching up with the Joneses" effect in households' preferences.

An interesting feature of my NOEM model is that it implies that, as in the models developed by Cavallo and Ghironi (2002) and Andersen and Beier (2000), delayed exchange-rate overshooting can be consistent with rational expectations. Furthermore, my NOEM model implies that, because I assume that international bond markets are imperfectly integrated, delayed exchange-rate overshooting can be observed along with a deviation from the textbook version of the condition of uncovered interest rate parity. In the Cavallo-Ghironi model, in contrast, the textbook version of the condition of uncovered interest rate parity always holds. As noted by Lane (2002), this is not a particularly attractive implication of their model because empirical evidence against the condition of uncovered interest rate parity is overwhelming.

I organize my analysis as follows. In Section 2, I discuss the NOEM model I use in my analysis. In Section 3, I use numerical simulations in order to study the properties of my model. I use impulse response functions to analyze how a productivity shock affects the exchange rate, and I conduct a sensitivity analysis to study how the results of my analysis depend upon the details of the specification of my model. There, I also study a generalized version of my model in which the condition of purchasing power parity does not hold. I use this generalized model to study whether imperfect financial market integration and "catching up with the Joneses" preferences not only imply that a productivity shock triggers a delayed overshooting of the nominal exchange rate, but also of the real exchange rate. In Section 4, I offer some concluding remarks.

2. The Model

As in Obstfeld and Rogoff (1995), the world is made up of two countries. The countries are of equal size. Each country is inhabited by infinitely-lived identical households. The households form rational expectations and maximize their expected lifetime utility. In addition, each country is populated by a continuum of firms owned by the households. The firms sell differentiated goods in a monopolistically competitive goods market. Because each firm has monopoly power on the goods market, it can set the price it charges for its good. When setting the price of their goods, firms are subject to sticky prices. The only production factor used by firms is labor. Firms hire labor in a perfectly competitive labor market. There is no migration of labor across countries.

2.1 Households' Preferences and Goods Market Structure

Domestic and foreign households have identical preferences. They maximize their expected lifetime utility, $U_t = E_t \sum_{s=t}^{\infty} \beta^{s-t} u_s$, where $0 < \beta < 1$ and E_t denotes the conditional-expectations operator. The period-utility function, u_t, is given by

$$u_t = (\sigma/(\sigma-1))(C_t - X_t)^{(\sigma-1)/\sigma} + \chi(M_t/P_t)^{1-\varepsilon}/(1-\varepsilon) - \kappa_t N_t^{\mu}/\mu, \tag{1}$$

where $\mu > 1$, $\sigma > 0$, $\varepsilon > 0$, $\chi > 0$, and κ_t is a stochastic labor-productivity index. In Equation (1), $C_t = \left[\int_O^1 c_t(z)^{(\theta-1)/\theta} dz\right]^{\theta/(\theta-1)}$, $\theta > 1$, denotes a real consumption index defined over a continuum of differentiated, perishable consumption goods, $c(z)$, where $z \in [0, \frac{1}{2}]$ for domestic goods and $z \in (\frac{1}{2}, 1]$ for foreign goods. The variable N_t denotes the households' labor supply, and M_t/P_t denotes real money holdings, where M_t denotes domestic nominal money balances (there is no currency substitution) and $P_t = \left[\int_0^1 p_t(z)^{1-\theta} dz\right]^{1/(1-\theta)}$ denotes the aggregate domestic price index. Here, $p_t(z)$ denotes the domestic currency price of a differentiated good. Because the law-of-one-price holds for each differentiated good and preferences are identical across countries, the condition of purchasing power parity holds: $P_t = S_t P_t^*$, where S_t denotes the nominal exchange rate and an asterisk denotes a foreign variable.

The crucial feature of the period-utility function given in Equation (1) is that households not only derive utility from consuming the consumption index, C_t, but also derive disutility from the variable X_t. This variable captures the “keeping up with the Joneses” feature of households’ preferences. As in Ljungqvist and Uhlig (2000), it is defined as

$$X_t = (1-\phi)\alpha C_{t-1}^A + \phi X_{t-1}. \tag{2}$$

where $0 \leq \phi < 1$, $0 \leq \alpha < 1$, and C_t^A denotes the average per capita consumption in the domestic economy. Equations (1) and (2) imply that if the other households in the economy increase their level of consumption, this results in a decrease in the level of utility a household attains and in an increase in the marginal utility a household derives from the consumption of the consumption basket, C_t. Because this also raises the marginal utility of consumption relative to the marginal disutility from supplying labor, the result is that households try to “catch up with the Joneses”. In consequence, the presence of the variable X_t in households’ period-utility function gives rise to a consumption externality because households do not take into account that their own consumption directly affects the desire of other households to “catch up”.

2.2 The Structure of Financial Markets

Households hold real balances and invest in internationally traded risk-less domestic and foreign one-period nominal bonds. As in Sutherland (1996) and Senay (1998), households face the problem that they have free access to the bond market of the country in which they reside, but incur transaction costs when investing in the international bond market. The transaction costs, Z_t, for investing in the international bond market are a quadratic function of the level of real funds, I_t, transferred from the domestic to the foreign bond market:

$$Z_t = 0.5\psi\, I_t^2, \tag{3}$$

where $\psi > 0$. Both Z_t and I_t are denominated in terms of the consumption index, C_t.

Households receive interest income for their holdings in domestic and foreign bonds, profit income for the ownership of domestic firms, and labor income. Households choose their optimal consumption and decide on their holdings in domestic bonds, foreign bonds, and domestic nominal balances. They also receive transfers from the government and incur transaction costs when investing in the international bond market. Hence, the dynamics of home households' domestic and foreign bond holdings can be described as

$$D_t = (1+R_{t-1})D_{t-1} + M_{t-1} - M_t + w_t N_t - P_t C_t - P_t I_t - P_t Z_t + \widetilde{\Pi}_t + P_t T_t, \tag{4}$$

$$F_t = (1+R_{t-1}^*)F_{t-1} + P_t^* I_t, \tag{5}$$

where D_t (F_t) denotes the quantity of domestic (foreign) currency denominated bonds, R_t (R_t^*) denotes the domestic (foreign) nominal interest rate, w_t denotes the nominal wage rate, $\widetilde{\Pi}_t(z)$ denotes nominal profit income, and T_t denotes real transfers. Because I abstract from government purchases of consumption goods, the budget constraint of the government implies that real transfers are financed by seignorage.

2.3 Individual Maximization

Assuming that the usual transversality condition applies, the following first-order conditions characterize the solution of households' utility maximization problem:

$$(C_t - X_t)^{-1/\sigma} = \lambda_t P_t, \tag{6}$$

$$\chi(M_t / P_t)^{-\varepsilon} + \beta P_t E_t(\lambda_{t+1}) = \lambda_t P_t, \tag{7}$$

$$\kappa_t N^{\mu-1} = \lambda_t w_t \, , \tag{8}$$

$$(1+R_t)\beta E_t(\lambda_{t+1}) = \lambda_t \, , \tag{9}$$

$$\lambda_t S_t - \beta(1+R_t^*)E_t(\lambda_{t+1}S_{t+1}) + \psi\lambda_t S_t I_t = \beta(1+R_t^*)\psi E_t(\lambda_{t+1}S_{t+1}I_{t+1}) \, , \tag{10}$$

where λ_t denotes the Lagrange multiplier. Similar first-order conditions can be derived for foreign households.

2.4 *Price Setting*

The production function of firms is of the form $y_t(z) = N_t(z)$. Nominal profits are defined as $\widetilde{\Pi}_t(z) = p_t(z)y_t(z) - w_t y_t(z)$. As in Calvo (1983), firms set the price of their goods in order to maximize the expected present value of current and future real profits. Future real profits are weighted by the probability, $0 < \gamma < 1$, that the current period price will still be in force in the future. Firms maximize $\max_{p_t(z)} E_t \sum_{s=t}^{\infty} \gamma^{s-t} \zeta_{t,s} \widetilde{\Pi}_s(z)/P_s$, where $\zeta_{t,s} \equiv \Pi_{j=s}^{t}(1+r_j)^{-1}$ and r_t denotes the domestic real interest rate. The solution to this profit-maximization problem is given by (see also, e.g., Sutherland 1996, Senay 1998, Yun 1996)

$$p_t(z) = \left(\frac{\theta}{\theta - 1}\right) \frac{E_t \sum_{s=t}^{\infty} \gamma^{s-t} \zeta_{t,s}(Q_s / P_s)(1/P_s)^{-\theta} w_s}{E_t \sum_{s=t}^{\infty} \gamma^{s-t} \zeta_{t,s}(Q_s / P_s)(1/P_s)^{-\theta}} \, , \tag{11}$$

where $Q_t \equiv nC_t + (1-n)C_t^* + nZ_t + (1-n)Z_t^*$ denotes aggregate world demand.

2.6 Model Solution

I study a symmetric monopolistic competition equilibrium in each country. To this end, I follow Obstfeld and Rogoff (1995) and log-linearize the model around a symmetric flexible-price steady state in which the foreign asset positions in both countries are zero. I then use the algorithm developed by Klein (2000) and McCallum (1998, 2001) to numerically simulate the calibrated log-linearized model. The calibration of the model is given in Table 1 and closely follows Sutherland (1996). Other authors have used similar calibrated parameters. The parameters that capture the "catching up with the Joneses" feature of households' preferences are calibrated as in Ljungqvist and Uhlig (2000). In my robustness analysis in Section 3.4, I will analyze the sensitivity of my results with respect to changes in the calibration and the structure of my model. It should also be noted that, in a symmetric equilibrium in each country, the model can be analyzed in terms of a representative household, implying that one can set $C_t = C_t^A$ when simulating the model.

— Insert Table 1 about here.—

3. Productivity Shocks and Delayed Overshooting

In order to study the effect of a productivity shock on exchange rate dynamics, I assume that the domestic economy is hit by a negative unit shock to the labor-productivity index in Equation (1). Such a shock results in a decrease in the disutility households' derive from supplying labor and, thereby, results in an increase of labor supply for any given real wage rate. Specifically, in my numerical simulations, I assume that the labor-productivity index follows the process

$$\hat{\kappa}_t = \rho_\kappa \hat{\kappa}_{t-1} + \varepsilon_{\kappa,t}, \tag{12}$$

where $0 \le \rho_\kappa \le 1$. A variable with a hat denotes deviations from the pre-shock steady state and $\varepsilon_{\kappa,t}$ denotes a white-noise disturbance term.

The impulse response functions I plot in Figures 1–5 summarize the results of my numerical simulations. For the sake of brevity, I focus on the impulse response functions for the domestic economy. In Figures 1– 3, I assume that a productivity shock is permanent, i.e., I set $\rho_\kappa = 1$. I study the propagation of a temporary productivity shock in my sensitivity analysis (Figure 4). In Figure 5, I study a generalized version of my model in which the condition of purchasing power parity does not hold.

3.1 The Implications of the "Catching up with the Joneses" Effect

I plot in Figure 1 the impulse response functions that I obtain when I simulate a version of my model in which the international bond market is perfectly integrated. I compare the impulse response functions for a benchmark economy, in which households do not care about the consumption of other households (solid lines), with the impulse response functions that I obtain if preferences feature a "catching up with the Joneses" effect (dashed lines). The impulse response functions illustrate that the "catching up with the Joneses" effect implies that households adjust their consumption only gradually in the aftermath of a productivity shock. A direct consequence of this is that consumption approaches its post-shock steady-state value only relatively slowly. The smooth dynamics of consumption transmit onto the dynamics of the demand-determined output. However, because a productivity shock implies that the disutility households derive from supplying labor decreases, output expands more rapidly than consumption, implying that the holdings of domestic households in foreign bonds start increasing.

This is in contrast to the reaction of the foreign bond position in an economy in which households' preferences do not feature a "catching up with the Joneses" effect.

— Insert Figure 1 about here.—

The impulse response functions further show that, due to the permanent nature of the shock, the exchange rate appreciates on impact to its new steady state value. Thus, there is no overshooting of the exchange rate. The appreciation of the exchange rate is larger if households' preferences feature a "catching up with the Joneses" effect because, in this case, domestic households start accumulating foreign bonds. The accumulation of foreign bonds further implies that consumption (output) is higher (lower) in the post-shock steady state if households' preferences exhibit a "catching up with the Joneses" effect. A direct implication of the accumulation of foreign bonds is that capital exports are positive in the short run, but negative in the long run due to the interest income earned by domestic households for their holdings in foreign bonds.

3.2 The Implications of Imperfect Bond Market Integration

In Figure 2, I plot the impulse response functions I obtain if I assume that households incur transaction costs when investing in the international bond market (dashed lines). I compare these impulse response functions with those I obtain if I assume that the transaction costs for investing in the international bond market are zero (solid line). In order to trace out the implications of imperfect bond market integration for the propagation of a productivity shock, I assume that households' preferences do not feature a "catching up with the Joneses" effect. This scenario has also been analyzed by Sutherland (1996).

It can be seen that imperfect bond market integration implies that the exchange rate undershoots its post-shock steady state value. The economic intuition for this result can be revealed by analyzing the implications of the transaction costs for international investments for the condition of uncovered interest rate parity. The log-linear version of this condition is given by

$$(1-\beta)(\hat{R}_t - \hat{R}_t^*) = E_t(\hat{S}_{t+1} - \hat{S}_t) + \tilde{\psi} E_t(\hat{I}_{t+1} - \hat{I}_t) \tag{13}$$

where $\tilde{\psi} \equiv \psi \overline{C}_0$ ($\overline{C}_0$ denotes the level of consumption in the pre-shock steady state). Equation (13) shows that with international bond markets being imperfectly integrated ($\tilde{\psi} > 0$), the expected change in the level of real funds transferred from the domestic to the foreign bond market (i.e., capital exports) exert a direct effect on international relative asset returns.

— Insert Figure 2 about here.—

The impulse response functions show that domestic households decrease their holdings in foreign bonds in the aftermath of a productivity shock. Hence, capital exports are negative. However, the impulse response functions also reveal that the economy rapidly converges to its post-shock steady state. As a result, the expected growth rate of capital exports is positive, implying that, in line with Equation (13), there is room for further appreciation expectations. In consequence, the nominal exchange rate undershoots its post-shock steady-state level in the short run. The undershooting of the exchange rate, in turn, implies that the expenditure-switching effect triggered by the exchange-rate movement is smaller if international bond markets are imperfectly integrated. The result is that the short-run effect of a productivity shock on the demand-determined output in a world of imperfectly integrated international bond markets falls short of its effect on output that can be observed if international bond markets are fully integrated.

3.3 Delayed Exchange Rate Overshooting

In Figure 3, I assume that international bond markets are imperfectly integrated and households' preferences feature a "catching up with the Joneses" effect. The most striking result is that the combination of these two modeling devices implies that, as in Cavallo and Ghironi (2002), a productivity shock gives rise to a delayed overshooting of the exchange rate. Thus, imperfect bond market integration and the "catching up with the Joneses" effect alone do not give rise to (delayed) exchange-rate overshooting, but a combination of these two modeling devices does.

— Insert Figure 3 about here.—

The "catching up with the Joneses" effect implies that households have a strong incentive to smooth consumption even though international bond markets are imperfectly integrated. This, in turn, implies that, as in Figure 1, households start accumulating foreign bonds in the aftermath of a productivity shock. The accumulation of foreign bonds takes place so rapidly that, with "catching up with the Joneses" preferences, the expected change in the volume of capital exports is positive in the first periods after the shock. According to Equation (13), the result is that households form appreciation expectations. In consequence, the exchange rate appreciates in the periods of time following a productivity shock. However, as the economy starts converging on its post-shock steady state, the rate of accumulation of foreign bonds is getting smaller, and the expected change in capital exports becomes negative. The impulse response functions reveal that this effect is strong enough to require, for the modified version of the condition of uncovered interest rate parity in Equation (13) to hold, depreciation expectations for the exchange rate. Depreciation expectations for the exchange rate, in turn, are only compatible with a rational expectations solution of the model if the exchange rate overshoots in the short run its long-run post-shock steady-state value.

3.4 Sensitivity Analysis

In Figure 4, I summarize the results of a sensitivity analysis. In order to compute the impulse response functions plotted in this figure, I varied the mark up, $\theta/(\theta-1)$, the parameters of the process that governs the "catching up with the Joneses" variable, X_t, the shock-persistence parameter, ρ_κ, and the degree of price stickiness, γ.

— Insert Figure 4 about here.—

It can be seen in Figure 4 that delayed exchange-rate overshooting in the aftermath of a productivity shock can also be observed if the mark up or the details of the specification of the process that governs the "catching up with the Joneses" variable are changed. In contrast, if a productivity shock is no longer highly persistent but transitory ($\rho_\kappa = 0.5$), there is neither an immediate nor a delayed overshooting of the exchange rate. If the degree of price stickiness is lowered (i.e., if the parameter γ assumes a relatively small numerical value), the impulse response functions show that there is still a delayed overshooting of the exchange rate in the aftermath of a permanent productivity shock. However, the delayed overshooting of the exchange rate becomes less pronounced if the degree of price stickiness decreases. In fact, if goods prices are sufficiently flexible, the delayed overshooting of the exchange rate is transformed into an immediate overshooting.

3.5. Deviations from Purchasing Power Parity

In this Section, I broaden the scope of my sensitivity analysis and ask whether imperfect bond market integration and the "catching up with the Joneses" feature of households' preferences give rise to a delayed overshooting of the *real* exchange rate. To this end, I study a generalized version of my model in which purchasing power parity does not hold. This is interesting because results of empirical research suggest that deviations from purchasing power parity may be large and persistent (Froot and Rogoff 1995; Rogoff 1996).

In order to study the impact of a shock to a productivity shock on the real exchange rate, I relax the assumption that households have identical preferences across countries. In line with the results of empirical research (see, e.g., McCallum, 1995), I assume that households have a home-product bias in preferences (see also Benigno and Thoenissen, 2003; Warnock 2003). This assumption formalizes the idea that households prefer to consume home-produced goods over foreign-produced goods for a given vector of relative prices.

I build a home-product bias into households' preferences by redefining the consumption index, C_t, as follows (see also Warnock 2003):

$$C_t = \left[\int_0^{1/2} \omega^{1/\theta} (c_t(h))^{(\theta-1)/\theta} \, dz + \int_{1/2}^{1} (2-\omega)^{1/\theta} (c_t(f))^{(\theta-1)/\theta} \, dz \right]^{\theta/(\theta-1)}, \tag{14}$$

where $\omega \in (0,2)$ and a h (f) denotes a domestic (foreign) good. If $\omega \in (1,2)$, then households have a bias for domestically produced goods. In contrast, if $\omega = 1$, then households' preferences do not feature a home-product bias and the model collapses to model I analyzed in Sections 2 and 3. If $\omega \in (0,1)$, then households prefer to consume goods produced abroad over goods produced at home for a given vector of relative prices. Equation (14) implies that the price index and the aggregate goods-demand curve are defined as follows:

$$P_t = \left[\int_0^{1/2} \omega (p_t(h))^{1-\theta}\, dz + \int_{1/2}^{1} (2-\omega)(p_t(f))^{1-\theta}\, dz \right]^{1/(1-\theta)}, \tag{15}$$

$$y_t(z) = (p_t(h)/P_t)^{-\theta}\, \omega \big(C_t + Z_t\big)/2 + (p_t(h)/(S_t P_t^*))^{-\theta}\,(2-\omega)\big(C_t^* + Z_t^*\big)/2\,. \tag{16}$$

Figure 5 summarize the results of my numerical simulations of the version of my model in which households' preferences feature a home-product bias. This figure plots on the left-hand side impulse response functions for the nominal exchange rate, and on the right-hand side impulse response functions for the real exchange rate. In the first row of Figure 5, I show impulse response functions for a model in which I assume $\omega = 1.5$. In the second row, I show impulse response functions for a model in which I assume $\omega = 1.9$. In both models, international bond markets are imperfectly integrated and households' preferences feature a "catching up with the Joneses" effect.

— Insert Figure 5 about here.—

The simulation results summarized in Figure 5 show that delayed overshooting of the nominal exchange rate also obtains if households' preferences feature a bias for domestically produced goods. Interestingly, however, the impulse response functions plotted in the first row reveal that a delayed overshooting of the nominal exchange rate does not necessarily imply a delayed overshooting of the real exchange rate. Thus, when my NOEM model is used to study the delayed exchange-rate overshooting phenomenon, one must be aware that situations can arise in which one can observe delayed overshooting of the nominal, but not of the real exchange rate. In such a situation, a delayed overshooting of the nominal exchange rate is overshadowed by the dynamics of the domestic and foreign aggregate price indexes.

This, however, does *not* mean that my model cannot be calibrated such that it implies that a productivity shock triggers a delayed overshooting of both the nominal and the real exchange rate. In fact, as the impulse response functions graphed in the second row of Figure 5 reveal, delayed overshooting of both the nominal and the real exchange rate obtains if the home-product bias in preferences is sufficiently strong.

4. Conclusions

The results of my analysis show that extending a standard NOEM model to incorporate imperfect bond market integration and a specification for households' preferences that features a "catching up with the Joneses" effect can give rise to a delayed exchange-rate overshooting in the aftermath of a productivity shock. The results of my sensitivity analysis have revealed that this tends to be the case if goods prices are sufficiently sticky and a productivity shock is relatively persistent. If households' preferences also feature a sufficiently strong home-product bias, a delayed overshooting of both the nominal and real exchange rate can be observed.

These results are interesting because they complement those reported by Cavallo and Ghironi (2002). They have shown that a productivity shock can give rise to a delayed overshooting of the exchange rate in an overlapping-generations NOEM model with endogenous money. Combining their results with my results suggests that delayed exchange-rate overshooting to a productivity shock may be quite common in NOEM models. Consequently, it may be interesting to examine more closely in future empirical research whether and, if so, in which countries a productivity shock triggers a delayed overshooting of the exchange rate.

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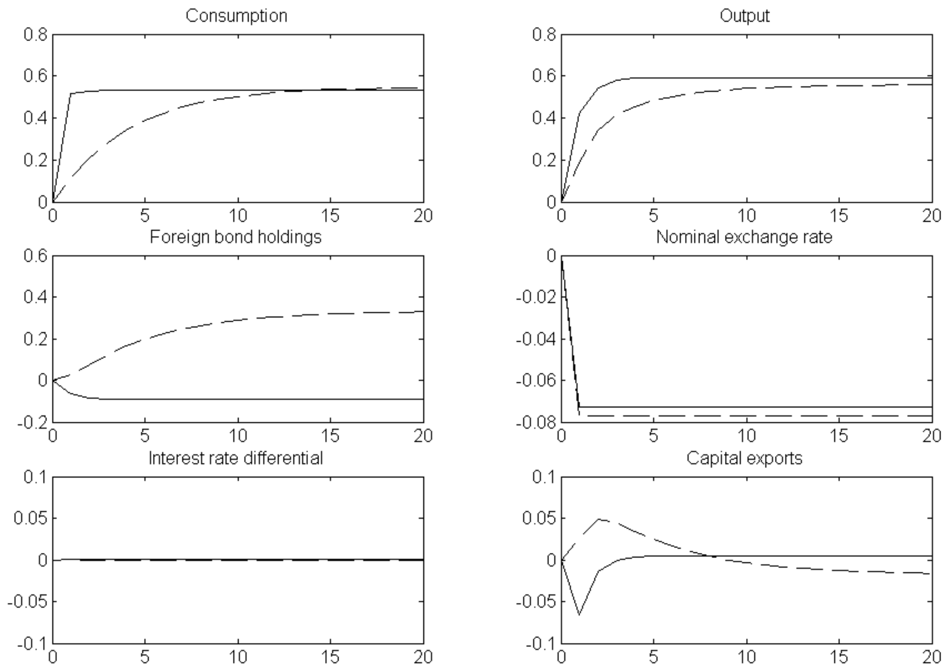
Table 1 – The calibrated parameters

Parameter	*Value*	*Description*
β	0.95	Subjective discount factor
σ	0.75	Intertemporal elasticity of substitution
θ	6.0	Intratemporal elasticity of substitution
ε	9.0	Inverse of the elasticity of utility from real balances
μ	1.4	Labor supply elasticity
$\tilde{\psi}$	5 (0)	Costs for undertaking positions in international financial market in the case of low (high) capital mobility
α	0.8	Parameter that captures the influence of lagged aggregate consumption on the "catching up with the Joneses" variable X_t
ϕ	0	Parameter that captures the influence of X_{t-1} on the "catching up with the Joneses" variable X_t

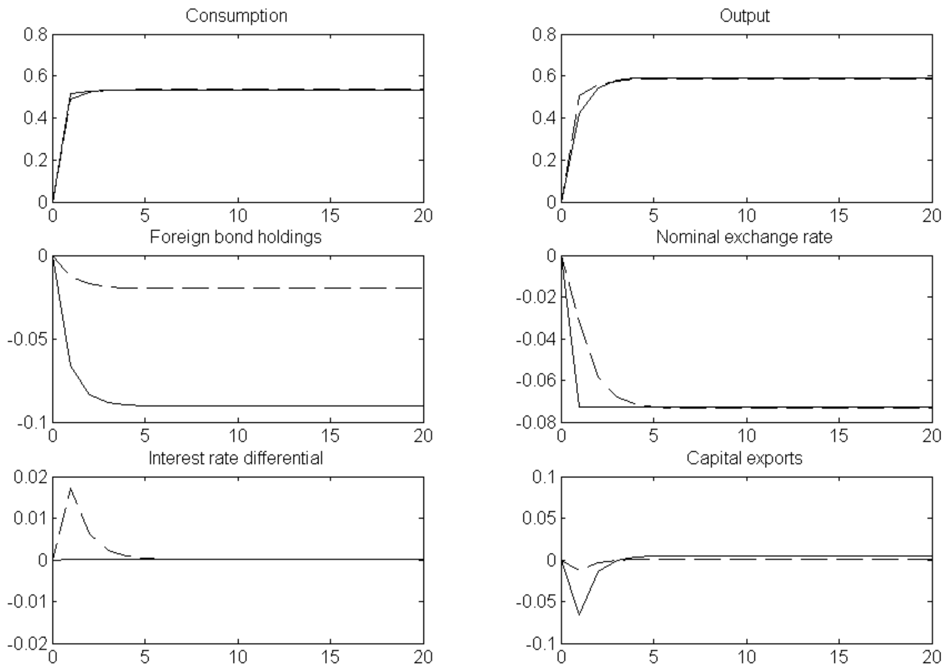
Note: The parameter values are as in Sutherland (1996). The same parameter values have been used by Senay (1998). The parameter values used by Sutherland are based on the estimates of Hairault and Portier (1993) and are in the range of parameter values commonly used to calibrate NOEM models. The values of the parameters that govern the process of the "catching up with the Joneses" variable are taken from Ljungqvist and Uhlig (2000).

Figure 1 – Catching Up With the Joneses Preferences and Macroeconomic Dynamics



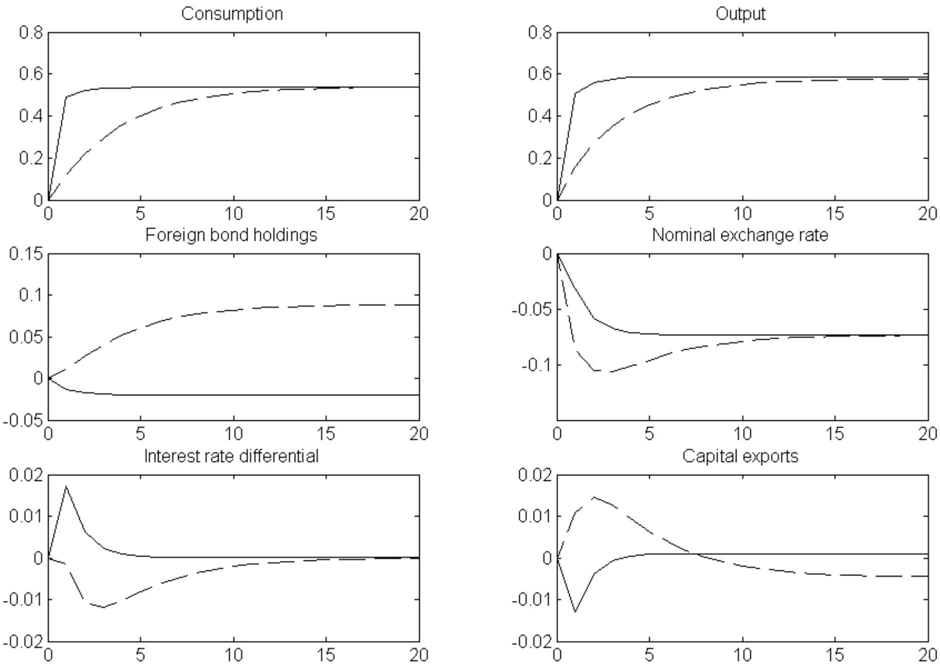
Notes: The figure plots the response of key domestic variables to a permanent negative unit shock to the labor-productivity index, $\hat{\kappa}_t$. Solid lines obtain upon setting $\alpha = 0$ and $\tilde{\psi} = 0$. Dashed lines obtain upon setting $\alpha = 0.8$ and $\tilde{\psi} = 0$. Consumption, output, and the exchange rate are measured as percentage deviations from the steady state. Capital exports and foreign bond holdings are measured as percentage deviations from the steady-state consumption level. Capital exports denote the volume of real funds transferred from the domestic to the foreign economy. The interest rate differential denotes the difference between the domestic and the foreign nominal interest rate. Interest rates are computed as percentage point deviations from the pre-shock steady state.

Figure 2 – Imperfect Bond Market Integration and Macroeconomic Dynamics



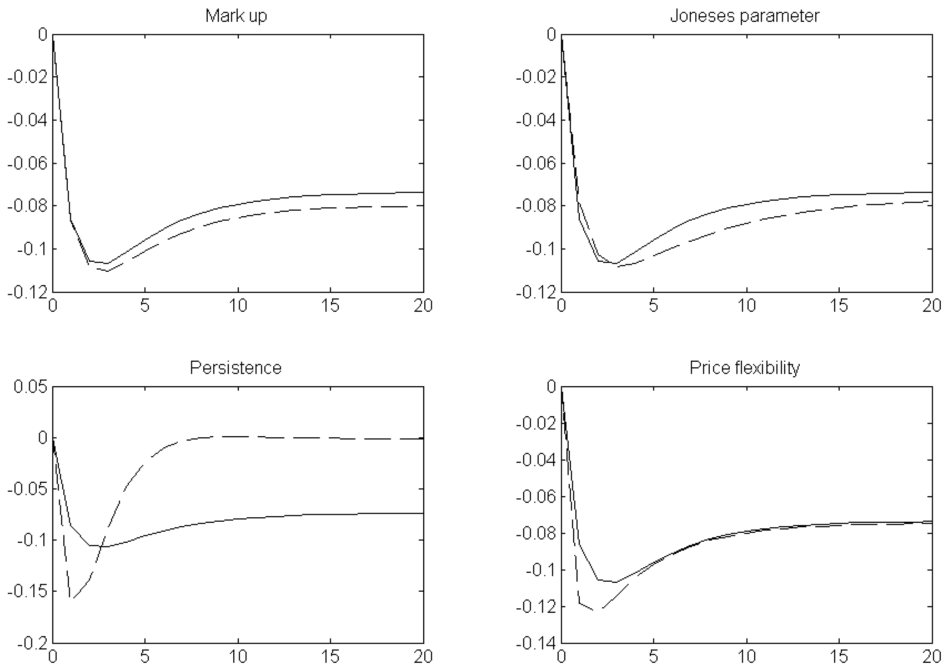
Notes: The figure plots the response of key domestic variables to a permanent negative unit shock to the labor-productivity index, $\hat{\kappa}_t$. Solid lines obtain upon setting $\alpha = 0$ and $\tilde{\psi} = 0$. Dashed lines obtain upon setting $\alpha = 0$ and $\tilde{\psi} = 5$. Consumption, output, and the exchange rate are measured as percentage deviations from the steady state. Capital exports and foreign bond holdings are measured as percentage deviations from the steady-state consumption level. Capital exports denote the volume of real funds transferred from the domestic to the foreign economy. The interest rate differential denotes the difference between the domestic and the foreign nominal interest rate. Interest rates are computed as percentage point deviations from the pre-shock steady state.

Figure 3 – Delayed Exchange Rate Overshooting



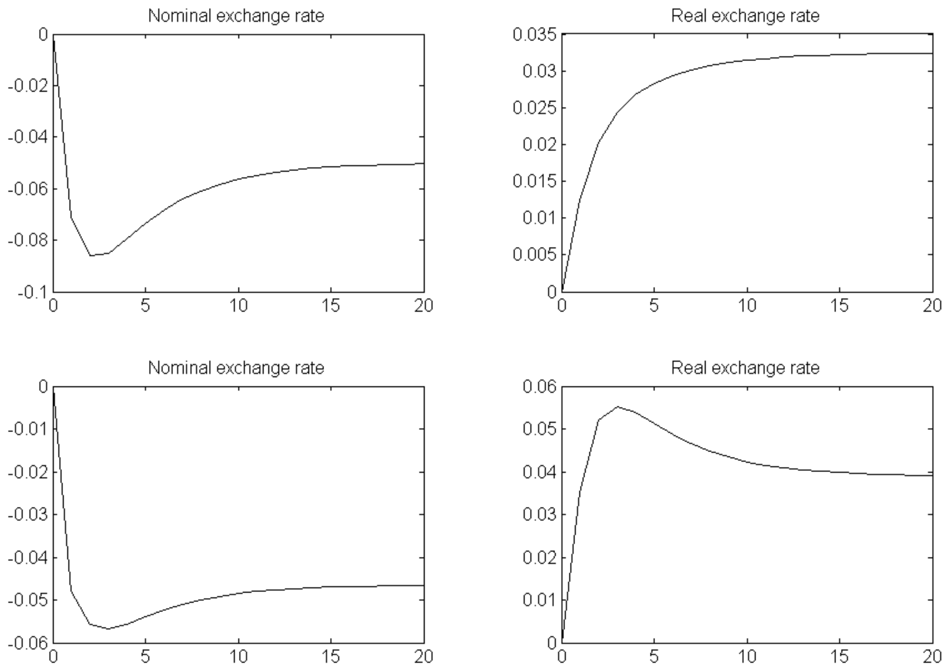
Notes: The figure plots the response of key domestic variables to a permanent negative unit shock to the labor-productivity index, $\hat{\kappa}_t$. Solid lines obtain upon setting $\alpha = 0$ and $\tilde{\psi} = 0$. Dashed lines obtain upon setting $\alpha = 0.8$ and $\tilde{\psi} = 5$. Consumption, output, and the exchange rate are measured as percentage deviations from the steady-state. Capital exports and foreign bond holdings are measured as percentage deviations from the steady state consumption level. Capital exports denote the volume of real funds transferred from the domestic to the foreign economy. The interest rate differential denotes the difference between the domestic and the foreign nominal interest rate. Interest rates are computed as percentage point deviations from the pre-shock steady state.

Figure 4 – Results of the Sensitivity Analysis



Notes: The figure plots the response of the nominal exchange rate to a negative unit shock to the labor-productivity index, $\hat{\kappa}_t$. All impulse response functions plotted in the figure are based on the assumption that $\alpha = 0.8$ and $\tilde{\psi} = 5$. The exchange rate is measured as percentage deviations from the steady state. Solid lines obtain upon setting the structural parameters of the model to their benchmark values given in Table 1. Dashed lines obtain upon changing the benchmark values to (from the upper-right to the lower-left cell) $\theta = 11$ (mark up), $\phi = 0.4$ (Joneses parameter), $\rho_\kappa = 0.5$ (persistence), and $\gamma = 0.25$ (price flexibility).

Figure 5 – Home-Product Bias in Preferences and Delayed Overshooting



Notes: The figure plots the response of the nominal and real exchange rate to a permanent negative unit shock to the labor-productivity index, $\hat{\kappa}_t$. All impulse response functions plotted in the figure are based on the assumption that $\alpha = 0.8$ and $\tilde{\psi} = 5$. The impulse response functions in the first (second) row of the figure obtain if the parameter that captures the home-product bias in households' preferences assumes the numerical value $\omega = 1.5$ ($\omega = 1.9$). The nominal and real exchange rate are measured as percentage deviations from the steady state.