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On the Hump-Shaped Output Effect of Monetary Policy in an Open Economy

by

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Abstract

Results of empirical research have revealed a characteristic hump-shaped effect of monetary policy shocks on output: the effect builds to a peak after several months and then gradually dies out. We analyze, in the context of a "new open economy macroeconomics" model, factors that imply a hump-shaped effect of a monetary policy shock on output. We find that a hump-shaped effect of output is likely to result if the model features a "catching up with the Joneses" effect, pricing-to-market behavior of firms, and imperfect international financial market integration.

Keywords: Monetary policy; Catching up with the Joneses; Pricing-to-market; International financial markets

JEL classification: F31, F32, F41

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1 Introduction

Results of empirical research have revealed a characteristic hump-shaped effect of a monetary policy shock on output: the effect builds to a peak after several months and then gradually dies out (see, e.g., Rotemberg and Woodford, 1997). In the theoretical literature, numerous attempts have been undertaken in order to explain this hump-shaped effect of a monetary policy shock on output (see, e.g., Christiano et al., 1998; Bernanke et al., 1999). Our contribution to this literature is that we analyze how a hump-shaped effect of a monetary policy shock on output can be modeled within the context of a dynamic optimizing "new open economy macroeconomic" (NOEM) sticky-price model of the type recently developed by Obstfeld and Rogoff (1995). We find that their prototype NOEM model implies a hump-shaped effect of a monetary policy shock on output if the model is extended to incorporate three features.

First, we incorporate pricing-to-market (PTM) behavior of firms as in Betts and Devereux (2000). PTM implies that firms can set different prices for their goods across segmented national goods markets. Combining PTM with the assumption of sticky prices implies that the prices of goods are sticky in the currency of the country that imports the goods. In line with the available empirical evidence (see, e.g., Engel and Rogers 1996, Knetter, 1993), assuming sticky prices and PTM limits the extent of pass-through of exchange rate fluctuations onto goods prices and cushions the expenditure-switching effect of exchange-rate changes.

Second, we incorporate a "catching up with the Joneses" effect in households' preferences as, e.g., in Abel (1990), Gali (1994), Campbell and Cochrane (1999), and Ljungqvist and Uhlig (2000). The "catching up with the Joneses" effect implies that households do not only derive utility from their own consumption, but also derive disutility from the aggregate consumption of the other households that reside in an economy. Because of this negative link between individual and aggregate consumption, the "catching up with the Joneses" effect in households' preferences captures the effect of envy and jealousy on households' behavior. Jung (2004) has recently demonstrated that adding a "catching up with the Joneses" effect to a closed-economy sticky-price dynamic general equilibrium model implies a hump-shaped response of output to a monetary policy shock. Choi and Jung (2003) have analyzed the implications of the "catching up with the Joneses" effect in households' preferences for optimal monetary policy in a NOEM model of a small open economy model with complete international financial markets and with producer-currency pricing. Our model differs from their model in that it features incomplete international financial markets and PTM. We find that, in an otherwise prototype NOEM model, a "catching up with the Joneses" effect in households' preferences can give rise to a hump-shaped effect of a monetary policy shock on output only if, in addition, firms follow a PTM strategy.

Third, we incorporate transaction costs for cross-border financial transactions as in Sutherland (1996) and Senay (1998). This implies that, in our NOEM model, international financial markets are imperfectly integrated. We find that imperfect integration of international financial markets widens substantially the range of parameter values, for which a "catching up with the Joneses" effect in households' preferences and PTM behavior of firms imply a hump-shaped effect of a monetary policy shock on output. Thus, imperfect financial market integration makes it more likely that the "catching up with the Joneses" effect implies a hump-shaped effect of a monetary policy shock on output. To show this property of our model, we follow Obstfeld and Rogoff (1996) in assuming that households can trade riskless bonds in international financial markets.

We organize the remainder of this paper as follows. In Section 2, we lay out the structure of our NOEM model. The structure of our NOEM model closely resembles the structure of the prototype NOEM models developed by Obstfeld and Rogoff (1996), Betts and Devereux (2001), Sutherland (1996), and Senay (1998). For this reason, our analysis of the main building block of our NOEM model will be reasonably short. In Section 3, we use impulse-response functions in order to study how the "catching up with the Joneses" effect in households' preferences, PTM behavior of firms, and the structure of international financial markets interact in shaping the response of output to a monetary policy shock. In Section 4, we conclude.

2 The Model

The world is made up of two countries, Home and Foreign. The two countries are of equal size. Each country is inhabited by infinitely-lived identical households and by a continuum of profit-maximizing firms owned by the households. Firms sell differentiated goods in a monopolistically competitive goods market. Because firms have monopoly power, they can set the prices of their goods. Firms can set different prices in their respective home country and abroad because national goods markets are segmented. As in Senay (1998) and Betts and Devereux (2001), the price setting of firms is governed by a staggered-contracts mechanism of the form developed by Calvo (1983). The only production factor used by firms is labor. Labor is internationally immobile.

2.1 Households' Preferences and Budget Constraints

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

$$u_t = \log(C_t - X_t) + \chi (M_t/P_t)^{1-\epsilon}/(1-\epsilon) - N_t^2/2 \,, \tag{1}$$

where $\epsilon > 0$ and $\chi > 0$. In the period-utility function, N_t, denotes hours worked and C_t denotes a real consumption index. This consumption index is defined as

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

where $z \in [0,1]$ denotes a household index and $\theta > 1$ denotes the substitutability of differentiated goods, $c_t(z)$. Households also derive utility from holding real balances, M_t/P_t, where M_t denotes the supply of Home central bank money (there is no currency substitution) and P_t denotes a consumer price index defined as

$$\begin{aligned} P_t \;=\; & \left[\int_0^{1/2} p_t(z)^{1-\theta}\, dz + \int_{1/2}^{1/2(1+\xi)} q_t(z^*)^{1-\theta}\, dz^* + \right. \\ & \qquad \left. + \int_{1/2(1+\xi)}^{1} \left(S_t\, p_t^*(z^*)\right)^{1-\theta}\, dz^* \right]^{1/(1-\theta)} \,, \end{aligned} \tag{3}$$

where $p_t(z)$ denotes the Home currency price of a Home-produced good, $q_t(z)^*$ denotes the Home currency price of a Foreign PTM good, S_t denotes the nominal exchange rate, and $p_t^*(z^*)$ denotes the Foreign currency price of a Foreign non-PTM good. As in Betts and Devereux (2001) and Senay (1998), the parameter $\xi \in [0,1]$ denotes the proportion of firms that follow a PTM strategy. If $\xi = 1$, all firms set the prices of their goods in terms of the currency of their buyers and, thus, follow a PTM strategy. If $\xi = 0$, all firms set the price of their goods in terms of the currency of the country in which they produce these goods, implying that there is no PTM and national goods markets are completely integrated.

The key feature of households' period-utility function 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" effect in households' preferences. As in Ljungqvist and Uhlig (2000), it is defined as

$$X_t = (1-\phi)\alpha C_{t-1}^A + \phi X_{t-1} \ , \tag{4}$$

where $0 \leq \phi < 1$, $0 \leq \alpha < 1$, and C_t^A denotes aggregate (per capita) consumption in the economy. According to Equations (1) and (4), an increase in the level of aggregate consumption results in a decrease in the level of utility a household attains and in an increase in the marginal utility a household derives from consumption. This results in an increase in the marginal utility of consumption relative to the marginal disutility from supplying labor and, thereby, implies that households try to "catch up with the Joneses".

Home and Foreign bonds are imperfect substitutes because households incur transaction costs when investing in Foreign-currency-denominated bonds. Following Sutherland (1996) and Senay (1998), we assume that transaction costs are a convex function of the amount of funds, I_t, transferred from the Home to the Foreign bond market. In the case of Home households, transaction costs are, thus, given by

$$Z_t = \frac{\psi}{2} I_t^2 \ , \tag{5}$$

where $\psi \geq 0$. Funds are denominated in terms of C_t. The period budget constraint of Home households is given by

$$d_t B_t + M_t = B_{t-1} + M_{t-1} + w_t N_t + \widetilde{\Pi}_t - P_t C_t - P_t I_t - P_t Z_t + P_t T_t \ , \tag{6}$$

where B_t denotes the quantity of Home-currency-denominated nominal bonds paying out one unit of Home currency in period $t+1$, d_t denotes the price of these bonds, T_t denotes real lump-sum transfers (denominated in terms of C_t), w_t denotes the nominal wage rate, and $\widetilde{\Pi}_t$ denotes the nominal profit income the household receives from domestic firms. Home households' holdings of Foreign bonds, F_t, evolve according to the following difference equation:

$$d_t F_t = F_{t-1} + (P_t/S_t)\, I_t \; . \tag{7}$$

2.2 Price Setting

The production function of firms is given by $y_t(z) = N_t(z)$. The nominal profits of a Home PTM firm consist of profits from sales at Home and of sales abroad: $\widetilde{\Pi}_t(z) = y_t^D(z)[p_t(z) - w_t] + y_t^F(z)[S_t q_t^*(z) - w_t]$, where $q_t^*(z)$ denotes the Foreign PTM price of a Home good and $y_t^D(z)$ and $y_t^F(z)$ denote the demand for the good of the firm at Home and abroad, respectively. Because prices are sticky, output is demand determined in the short run. The demand functions are given by

$$y_t^D(z) = \frac{1}{2}\,(p_t(z)/P_t)^{-\theta}\,(C_t + Z_t) \;, \tag{8}$$

$$y_t^F(z) = \frac{1}{2}\,(q_t^*(z)/P_t^*)^{-\theta}\,(C_t^* + Z_t^*) \;. \tag{9}$$

As in Senay (1998) and Betts and Devereux (2001), firms' price setting is subject to a discrete time version of the sluggish price-setting mechanism developed by Calvo (1983). The basic assumption underlying the Calvo-style price-setting mechanism is that, with probability $0 < \gamma < 1$, a firm cannot revise the price of its good in any given period of time. A consequence of this assumption is that PTM firms set the current Home and Foreign price of their product, $p_t(z)$ and $q_t^*(z)$, so as to maximize the expected discounted present value of current and future profits. The following equations give the solution to a PTM firm's maximization problem:

$$p_t(z) = \left(\frac{\theta}{\theta - 1}\right) \frac{\mathrm{E}_t \sum_{s=t}^{\infty} \gamma^{s-t} R_{t,s} C_s (1/P_s)^{-\theta} w_s}{\mathrm{E}_t \sum_{s=t}^{\infty} \gamma^{s-t} R_{t,s} C_s (1/P_s)^{-\theta}} \;, \tag{10}$$

$$q_t^*(z) = \left(\frac{\theta}{\theta - 1}\right) \frac{\mathrm{E}_t \sum_{s=t}^{\infty} \gamma^{s-t} R_{t,s} C_s^* (1/P_s^*)^{-\theta} w_s}{\mathrm{E}_t \sum_{s=t}^{\infty} \gamma^{s-t} R_{t,s} C_s^* (1/P_s^*)^{-\theta} S_s} , \tag{11}$$

where $R_{t,s} \equiv \prod_{j=s}^{t} d_j$ is the market discount factor. Similar expressions can be derived for the profit-maximizing prices, $q_t(z^*)$ and $p_t^*(z^*)$, set by Foreign PTM firms.

Because non-PTM firms set a single Home-currency-denominated price for both the Home and Foreign goods market, the solution to their profit maximization problem is identical to the solution given in Equation (10).

2.3 Government

Governments finance real transfers by seignorage. The period-budget constraint for the Home government can, thus, be written as

$$T_t = (M_t - M_{t-1}) / P_t . \tag{12}$$

The Home money supply is governed by a simple AR(1) process:

$$\widehat{M}_t = \kappa \widehat{M}_{t-1} + \epsilon_{M,t} , \tag{13}$$

where $\epsilon_{M,t}$ denotes a serially uncorrelated stochastic disturbance term, and the parameter $\kappa \in [0, 1]$ captures the persistence of a monetary policy shock.

2.4 Model Calibration and Model Solution

We solve the model in three steps. In a first step, we follow the NOEM literature and log-linearize the model around a symmetric flexible-price steady state in which households' asset position is zero. In a second step, we calibrate the model. The calibration of the model is given in Table 1. The parameter values we use, including the parameter that captures the transaction costs for investing in the international bond market, are as in Sutherland (1996) and Senay (1998). These parameter values are standard in the NOEM literature. We calibrate the parameters of the process that captures the "catching up with the Joneses" effect in households' preferences as in Ljungqvist and Uhlig (2000). With respect to the money supply process in Equation (13), we set $\kappa = 1$, i.e., we assume that a monetary policy shock is permanent. We study the macro-dynamic effects of a Home monetary policy shock, i.e., we assume that there is no monetary policy shock in the Foreign economy. In a third step, we use the algorithm developed by Klein (2000) and McCallum (1998, 2001) in order to numerically solve the model. The solution of the model determines the paths of the endogenous variables of the model in terms of the predetermined and exogenous variables of the model.

— Insert Table 1 about here. —

3 Properties of the Model

We use impulse response functions in order to analyze the properties of our model. To this end, we proceed in two steps. In a first step, we study how the price-setting behavior of firms affects the implications of the "catching up with the Joneses" effect in households' preferences for the propagation of a monetary policy shock (Section 3.1). We show that in our simulations the "catching up with the Joneses" effect implies a hump-shaped effect of a monetary policy shock on output only if all firms follow a PTM price-setting strategy ($\xi = 1$). In a second step, we analyze how the introduction of transaction costs for cross-border investments in international bond markets affects the propagation of a monetary policy shock (Section 3.2). We show that allowing for imperfect integration of international bond markets renders it possible to generate a hump-shaped effect of a monetary policy shock on output even if a non-negligible proportion of firms does not follow a PTM price-setting strategy ($\xi < 1$). This is an important result because empirical evidence suggests that in many countries, apart from the United States, a non-negligible proportion of imports is not invoiced in the importer's currency (Obstfeld, 2002). Thus, extending our NOEM model to incorporate the feature that international bond markets are imperfectly integrated should improve the power of our model to explain the hump-shaped effect of a monetary policy shock on output that has been documented in numerous empirical studies.

3.1 Price Setting and "Catching Up with the Joneses"

To set the stage for our analysis, we plot in Figure 1 the response of key macroeconomic variables to a unit, one time, permanent Home monetary policy shock. We compare impulse response functions for a model that does not feature a "catching up with the Joneses" effect in households' preferences (solid line) with impulse response functions for a model featuring a "catching up with the Joneses" effect in households' preferences (dashed line). In order to compute the impulse response functions plotted in Figure 1, we assume full PTM ($\xi = 1$) and full international bond market integration ($\psi = 0$). The impulse response functions illustrate that the Home monetary policy shock gives rise to a temporary increase in Home output. As in the PTM model developed by Betts and Devereux (2000), a Home monetary policy shock has a negative spill over effect on Foreign consumption and a positive spill over effect on Foreign output. The result is a close international comovement of output. Furthermore, in the aftermath of the shock, as firms start repatriating profits, both the nominal and the real exchange rate depreciate. As in Betts and Devereux (2000), the nominal exchange rate overshoots in the short-run its long-run post-shock steady-state value. Thus, the model implies the type of overshooting of the exchange rate that was first described by Dornbusch (1976).

— Insert Figure 1 about here. —

Adding the "catching up with the Joneses" effect in households' preferences hardly affects the impact of a monetary policy shock on the nominal and the real exchange rate. The main consequence of adding the "catching up with the Joneses" effect in households' preferences is that the response of consumption and output to a monetary policy shock becomes much smoother. Figure 1 illustrates that, with the "catching up with the Joneses" effect in households' preferences, the effect of a monetary policy shock on consumption and output builds up gradually before the maximum effect is attained. After the maximum effect has been attained, the effect of a monetary policy shock on consumption and output gradually dies out. Thus, with a "catching up with the Joneses" effect in households' preferences, the model implies a hump-shaped effect of a monetary policy shock on consumption and output. In contrast, the maximum effect of a monetary policy shock on consumption and output is realized in the immediate aftermath of a monetary policy shock if the model does not feature a "catching up with the Joneses" effect.

The model we study in Figure 1 features PTM behavior of firms ($\xi = 1$, i.e., all firms follow a PTM strategy) and a "catching up with the Joneses" effect in households' preferences. It is, therefore, interesting to ask whether the "catching up with the Joneses" effect gives rise to a hump-shaped effect of a monetary policy shock on output if not all firms follow a PTM strategy. In order to answer this question, we compute impulse response functions of output for a number of alternative numerical values of the PTM parameter, ξ (Figure 2).

— Insert Figure 2 about here. —

The main result illustrated by the impulse response functions given in Figure 2 is that the numerical simulations of our model result in a hump-shaped effect of a monetary policy shock on output only if we set $\xi = 1.0$. Even if we set the PTM parameter to $\xi = 0.98$ (or to $\xi = 0.99$, not shown in Figure 2), there is no hump-shaped response of output to a monetary policy shock. We conclude that adding a "catching up with the Joneses" effect to a standard NOEM model with PTM behavior on the side of firms gives rise to a hump-shaped response of output to a monetary policy shock only under restrictive assumptions regarding the price-setting behavior of firms.

3.2 Imperfect International Integration of Bonds Markets

We now assume that international bond markets are imperfectly integrated ($\psi > 0$). We use the impulse response functions shown in Figure 3 to analyze how this assumption affects the implications of PTM behavior on the side of firms and "catching up with the Joneses" behavior on the side of households for the output effect of a monetary policy shock. In order to compute the impulse response functions given in Figure 3, we set $\xi = 0.9$, i.e., we assume that not all firms follow a PTM price-setting strategy. The key result highlighted by Figure 3 is that the assumption of imperfect international bond market integration implies that a monetary policy shock gives rise to a hump-shaped effect of output even when not all firms follow a price-setting strategy. The economic intuition behind this result is that imperfect international bond market integration requires a closer comovement of output and consumption and, thereby, implies that the hump-shaped effect of consumption caused by the "catching up with the Joneses" effect translates onto output. We conclude that extending our NOEM model to incorporate the assumption of transaction costs for cross-border financial transactions, $\psi > 0$, widens the interval of the PTM parameter, ξ, for which a monetary policy shock gives rise to a hump-shaped effect of output.

— Insert Figure 3 about here. —

In order to quantitatively substantiate this conclusion, we analyze in Figure 4 the range of numerical values of the PTM parameter, ξ, admitting a hump-shaped effect of a monetary policy shock on output. We plot impulse response functions for two alternative specifications of the transaction cost parameter, $\psi = 5.0$ (Panel A) and $\psi = 15.0$ (Panel B). Figure 4 illustrates that the higher the transaction cost parameter is, the wider the range of numerical values of the PTM parameter that implies a hump-shaped effect of a monetary policy shock on output. In the case of $\psi = 15.0$, even a numerical value of the PTM parameter as low as $\xi = 0.75$ allows a hump-shaped effect of a monetary policy shock on output to be simulated.

— Insert Figure 4 about here. —

4 Conclusions

Empirical evidence has shown that a monetary policy shock often triggers a hump-shaped effect of output. In recent years, economic theorists have developed a number of competing models to explain this hump-shaped effect of a monetary policy shock on output. Our analysis in this paper has contributed to this strand of research in economic theory.

We have shown that incorporating a "catching up with the Joneses" effect in households' preferences into an otherwise standard NOEM model featuring PTM behavior of firms implies a hump-shaped effect of a monetary policy shock on output only under restrictive assumptions regarding the price-setting behavior of firms. A key result of our analysis is that the range of parameter values for which PTM behavior of firms and a "catching up with the Joneses" effect in households' preferences imply a hump-shaped effect of a monetary policy shock on output widens substantially if we allow for imperfect international financial market integration.

Because the implications of our model for the response of output to a monetary policy shock depend upon the numerical values of its structural parameters, it would be interesting to empirically estimate these structural parameters. In particular, it would be interesting to simultaneously estimate all structural parameters of our model by means of the type of maximum-likelihood estimators that have been used in the recent macroeconomics literature for the estimation of rational expectations dynamic general equilibrium models (e.g., Ireland, 2003). In doing this, one could study whether the data provide evidence in favor of our explanation for the hump-shaped response of output to a monetary policy shock. We leave this to future research.

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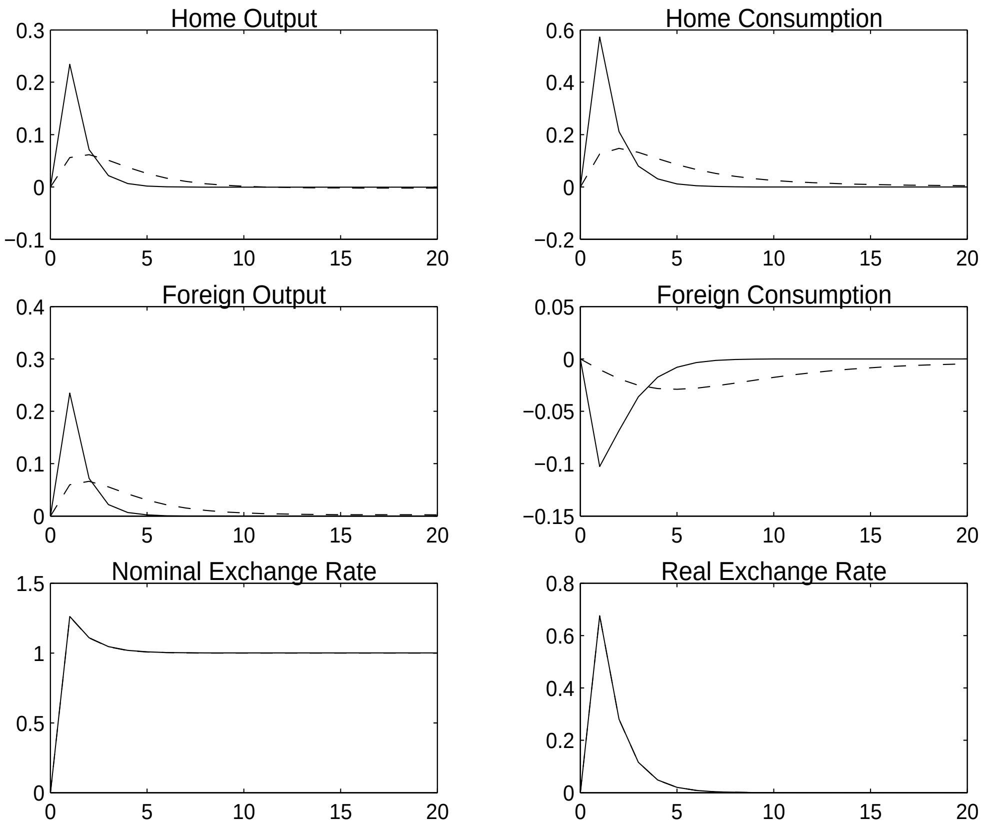
Table 1: The calibrated parameters.

Parameter	Value	Description
β	1/1.05	Subjective discount factor
θ	6.0	Intratemporal elasticity of substitution
ϵ	9.0	Inverse of the elasticity of utility from real balances
$\widetilde{\psi}$	5 (0)	Cost for undertaking positions in international bond markets in the case of low (high) capital mobility
γ	0.5	Probability of not adjusting prices
ϕ	0	Parameter of the process that governs the dynamics of x_t
α	0.8	Parameter of the process that governs the dynamics of x_t

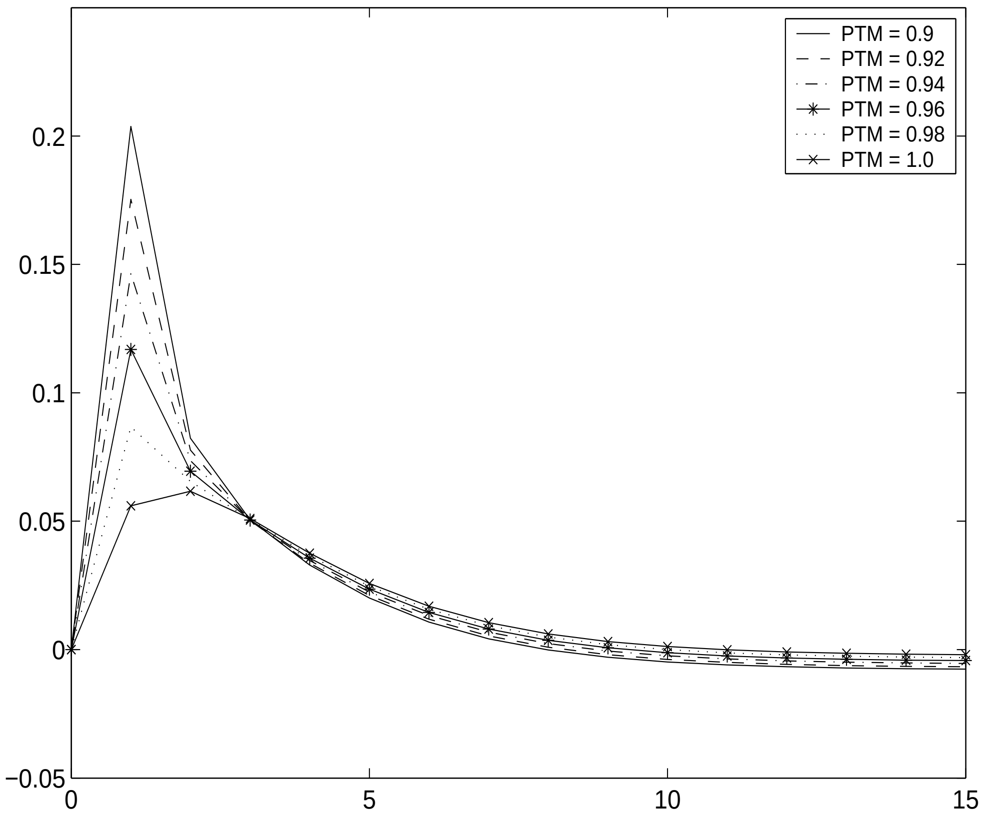
Note: For parameter values, see Sutherland (1994) and Ljungqvist and Uhlig (2000). The transaction cost parameter is defined as $\widetilde{\psi} = \psi\overline{C}$, where $\overline{C}$ denotes steady-state consumption.

Figure 1: Effects of a Home monetary policy shock when international bond markets are fully integrated.



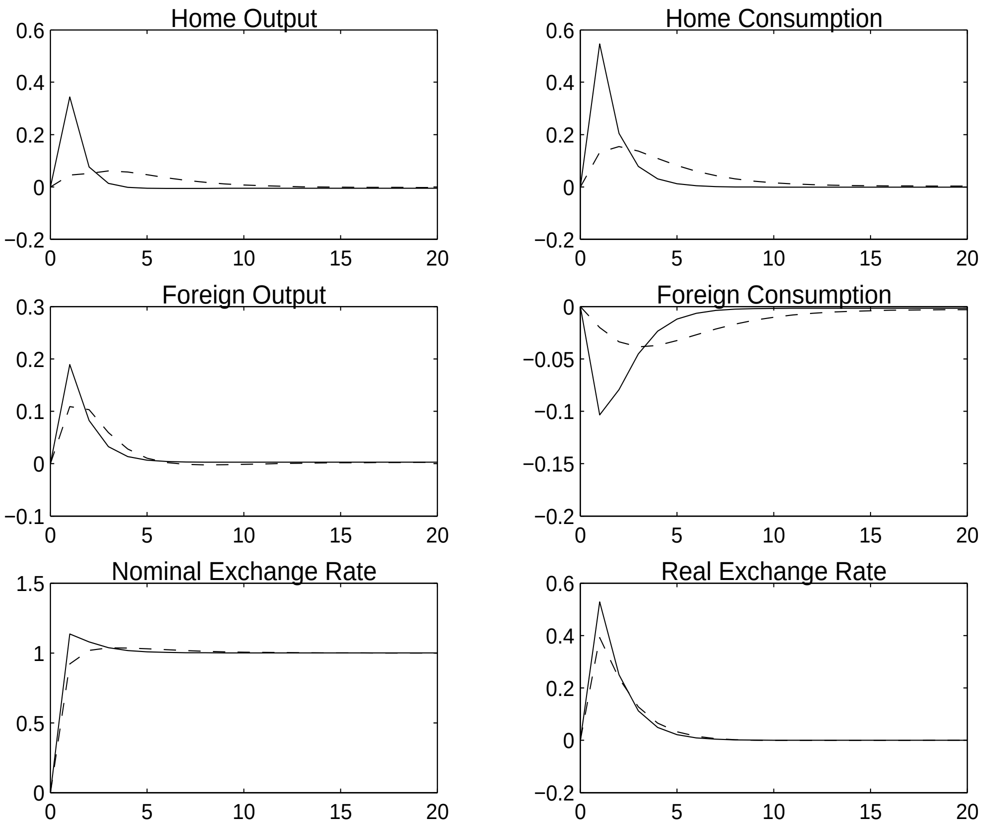
Note: This figure gives impulse response functions for a model in which all firms follow a PTM price-setting strategy ($\xi = 1$). International bond markets are assumed to be perfectly integrated ($\psi = 0$). Solid (Dashed) lines apply to a model without (with) "catching up with the Joneses" effect. All variables are measured as percentage deviations from the steady state. In the model with a "catching up with the Joneses" effect in households' preferences, we set $\phi = 0$ and $\alpha = 0$.

Figure 2: Output response to a monetary policy shock for alternative numerical values of the PTM parameter.



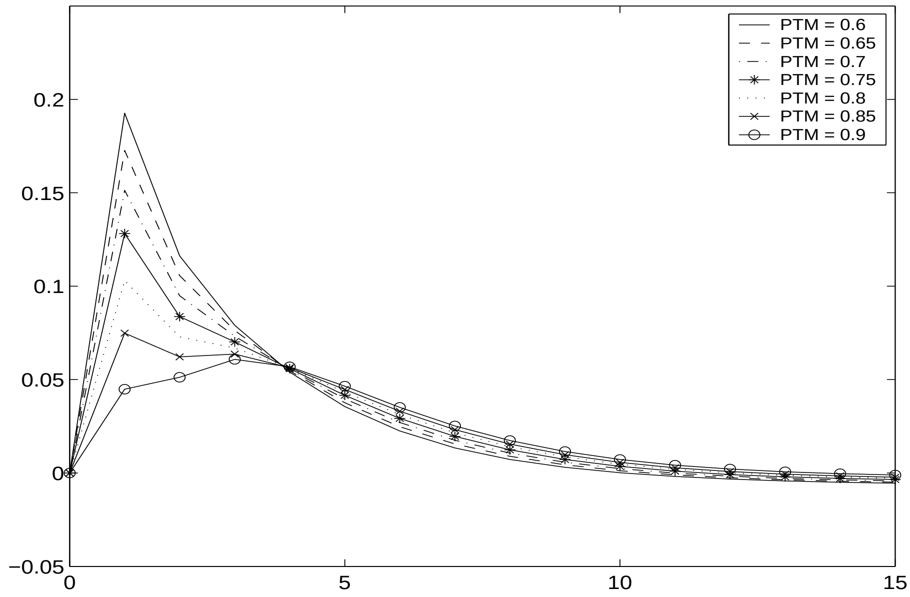
Note: This figure gives the impulse response function for output for a model featuring a "catching up with the Joneses" effect in households' preferences ($\phi = 0$ and $\alpha = 0.8$). Output is measured in terms of percentage deviations from the steady state. International bond markets are assumed to be perfectly integrated ($\psi = 0$).

Figure 3: Effects of a monetary policy shock when international bond markets are imperfectly integrated.

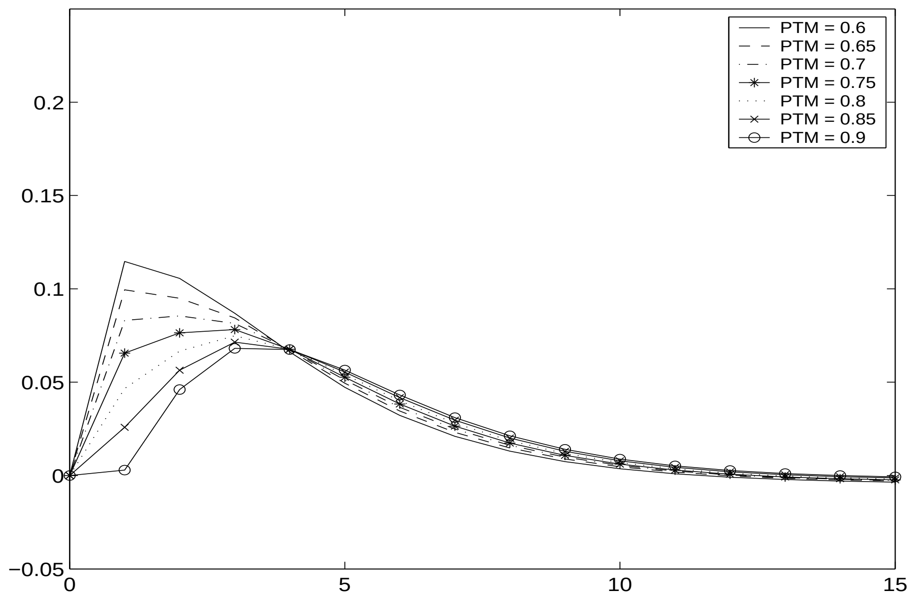


Note: This figure gives impulse response functions for a model in which the PTM parameter assumes the numerical value $\xi = 0.9$. International bond markets are imperfectly integrated ($\psi = 5.0$). Solid (Dashed) lines apply in a model without (with) "catching up with the Joneses" effects. All variables are measured as percentage deviations from the steady state. In the model with a "catching up with the Joneses" effect in households' preferences, we set $\phi = 0$ and $\alpha = 0.8$.

Figure 4: Output response to a monetary policy shock when international bond markets are imperfectly integrated.



(a) Panel A: $\psi = 5.0$



(b) Panel B: $\psi = 15.0$

Note: Output is measured as percentage deviations from the steady state.