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REAL EXCHANGE RATE VOLATILITY AND DISCONNECT: AN EMPIRICAL INVESTIGATION

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Abstract

A two-country model that incorporates many features proposed in the New Open Economy Macroeconomics literature is developed in order to replicate the volatility of the real exchange rate and its disconnect with macroeconomic variables. The model is estimated using data for the euro area and the U.S. and Bayesian methods. The analysis delivers the following results: (a) international price discrimination, home bias and shocks to the uncovered interest rate parity (UIRP) condition are key features to replicate the variance of the real exchange rate; (b) home bias, shocks to the UIRP condition and to production technologies help replicating the disconnect; (c) distribution services intensive in local nontradeables are an important source of international price discrimination.

JEL Classification: F32, F33, F41, C11.
Keywords: international economic cycle, real exchange-rate volatility, pass-through, international transmission of shocks.

Contents

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1 Introduction

While the real exchange rate plays an important role in the allocation of resources and expenditures across countries, its short run movements are much less linked with prices and quantities than one would expect (*real exchange rate disconnect*). On the one hand, the high volatility displayed by the exchange rate has little impact on that of other macroeconomic variables such as output and consumption. On the other hand, this high volatility does not seem to be induced by changes in fundamental determinants of the exchange rate (as it is the case for other macroeconomic variables).

One explanation of the puzzle is based on price rigidities and on the implications of international price discrimination. Given the compelling case against the law of one price and the evidence of a relative stability of import and consumer prices vis-a-vis nominal exchange rate fluctuations (imperfect pass-through), several papers in the New Open Economy Macroeconomics (NOEM) framework have relaxed the producer currency pricing assumption (PCP) of the seminal Obstfeld and Rogoff's (1995) *Redux* model.[1] Among others, Chari *et al.* (2002) show that a high degree of price stickiness is necessary to reproduce the volatility of the real exchange rate when the economy is hit by monetary policy and technology shocks. Devereux and Engel (2002) study the conditions under which a model with local currency pricing (LCP), heterogeneity in international price-setting, incomplete international financial markets and shocks to the uncovered interest parity (UIRP) can generate large exchange rate volatility that, in addition, does not influence the volatility of other macroeconomic variables.[2] The implied international segmentation in product markets and incomplete risk sharing eliminate the equality between relative prices and marginal rates of substitution. Therefore, changes in real exchange rate are not linked to changes in the product market and the former can be driven by shocks to the UIRP condition without significant spillover to other macroeconomic variables. More recently, Corsetti *et al.* (2005) show that, independently of nominal frictions, incomplete exchange rate pass-through and sticky prices can result from endogenous price discrimination in presence of a large component of nontradable goods and services in the consumer price of tradable goods.

Another explanation is based on quantities and looks at ways to introduce differences in the consumption bundles consumed in each country. It amounts to relaxing the as-

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[1] See Devereux and Engel (2003).

[2] See also Betts and Devereux (2000). Devereux and Engel (2002) motivate the shocks to the UIRP by assuming the presence of foreign currency traders with biased expectations about future exchange rates. Duarte (2003) and Kollmann (2005) analyze the relationship between exchange rate regimes and business cycle in models featuring LCP and a UIRP shock. See also Jeanne and Rose (2002).

sumption of symmetric preferences across countries, on the one hand, and that of full tradeability of all goods, on the other. These two assumptions, in fact, when coupled with the absence of international price discrimination are enough to ensure that the purchasing power parity condition holds and hence that the real exchange rate is constant. The assumption of symmetric preferences is relaxed by introducing home bias. The full tradeability of all goods is relaxed by introducing nontradeable goods. As for the role of home bias, Warnock (2003) shows that when preferences are biased toward domestically-produced goods there are wealth transfers across countries and large short-run deviations from consumption-based purchasing power parity. The role of nontradable goods has been studied by Stockman and Tesar (1995), Hau (2000), Benigno and Thoenissen (2006), Burstein, Eichenbaum and Rebelo (2006) and Dootsey and Duarte (2007). The main result from these contributions is that nontraded goods increase the volatility of the real exchange rates relative to its volatility in the model without nontraded goods and lowers the cross-correlation of exchange rates with other variables.

In this paper we provide an empirical and systematic assessment of the implications of several economic features that have been introduced in the literature to explain the real exchange rate volatility and disconnect. To that purpose, we estimate a two-country stochastic general equilibrium model for the U.S. and the euro area with Bayesian techniques.

We assume home bias, sticky import prices in the currency of the buyer (LCP), distribution services along the lines of Corsetti *et al.* (2005), nontradeability of some goods. The presence of a distribution sector allows to distinguish between pass-through at the border and at consumer level, the latter being usually lower than the former, and helps in further breaking the link between real exchange rate and other macroeconomic variables.[3] We allow for wage and nontradeables price stickiness as additional tools to insulate fundamentals from real exchange rate fluctuations and assume labor-based production (there is no capital accumulation). We characterize the behaviour of the central banks through a modified Taylor rule. International financial markets are incomplete (a riskless bond is internationally traded) and there are shocks to the UIRP.

Several interesting results emerge from the analysis. First, relaxing in turn some of the above mentioned features we prove that many combinations of the rigidities introduced in the model are sufficient to replicate the volatility of the real exchange rate and its disconnect with fundamentals, but they do so through different mechanisms. Second, the presence of nontradeables is what allows the model(s) to replicate the real exchange rate stylized facts without resorting to economically extreme outcomes. In fact, when we consider only tradables in the model, the home bias estimate increases to one. Another general lesson is that home bias, international price discrimination and UIRP shock are all essential ingredients to generate high volatility. Home bias and technology shocks are crucial to generate the disconnect since they help limiting the transmission of wide and persistent real exchange rate fluctuations to consumer prices and consumption. Finally,

[3]See Kollman (2001) for a quantitative analysis of the relation between real exchange rate volatility and staggered price and wage setting in a dynamic model. See Campa and Goldberg (2008) for empirical evidence on the role of the distribution sector in reducing the sensitivity of consumer prices to exchange rate fluctuations.

the distribution sector is a key feature of international price discrimination. Interestingly, the degree of import price stickiness is not extremely high at the border and allows to generate a positive correlation between real exchange rate and terms of trade. This is consistent with the empirical evidence given by Obstfeld and Rogoff (2000) in favor of the expenditure-switching effect of nominal exchange rate acting at the border and not at the consumer level.

Our work can be related to recent contributions that exploit advances in Bayesian estimation to empirically analyze NOEM models.[4] Adolfson *et al.* (2007) estimate an open economy model featuring incomplete pass-through using euro area data (they take the rest of the world as exogenous). Lubik and Schorfheide (2005), De Walque and Wouters (2004) and Rabanal and Tuesta (2006) estimate two-country models on euro area and U.S. data focusing on the role of import price stickiness and incomplete pass-through for international spillover and real exchange rate fluctuations. Rabanal and Tuesta (2007) analyze the role of nontradables and distribution services.[5] We deviate from those contributions by empirically and systematically assessing the whole set of determinants of the real exchange rate fluctuations (home bias, international price discrimination due to price stickiness and distribution services, nontradables, UIP shocks).

The paper is organized as follows. Section 2 describes the model. Section 3 reports the estimates and the empirical validation of the model. Section 4 analyses the sources of the real exchange rate volatility and disconnect. Section 5 reports impulse responses and variance decomposition analyses. Section 6 concludes.

2 The model

There are two countries of equal size (normalized to one), denominated home and foreign. In each country there is a continuum of agents on the unit interval. We allow for home bias in consumption preferences. Each country is specialized in the production of tradeable and nontradeable goods (the two sectors have equal size, normalized to one). Each sector is characterized by monopolistic competition. Consistently with most of the NOEM literature we abstract from capital accumulation and assume that labor is the only input and that the production function is shifted by random variations in technology. Firms producing tradeables are engaged in international price discrimination. This feature is the combination of the LCP assumption and distribution services which are intensive in local nontradeables. International financial markets are incomplete. A riskless bond is internationally traded and a modified uncovered interest parity condition links the expected nominal exchange rate depreciation to the interest rate differential and a stochastic risk premium. Wages and prices are sticky. Finally, interest rates are set by

[4]See Bergin (2003, 2004) for a maximum likelihood approach to estimate NOEM models. See Smets and Wouters (2003) for a Bayesian neo-keynesian closed economy model of the euro area.

[5]De Walque and Wouters (2004) also have a distribution sector. However, it is not intensive in local nontradeables and it is not a source of international price discrimination. Lubik and Schorfeide (2005) have complete pass-through at the border, but not at consumer level thanks to price stickiness. Rabanal and Tuesta (2006) have incomplete pass-through at the border but do not distinguish between border and consumer levels. Justiniano and Preston (2006) estimate a small open economy model.

the monetary authorities according to feedback rules.

In what follows we report the equilibrium conditions of the home country. Those referring to the foreign country are similar. Variables with a star (*) refer to the foreign country.

2.1 Firms

There are three categories of firms in the economy: producers of tradeables, of nontradeables, and of distribution services. The two former producers are monopolistic suppliers of their specific brand. The latter acts under perfect competition.

2.1.1 International price discrimination

Following Corsetti *et al.* (2005), we assume that firms producing tradeables need distribution services intensive in local nontradeables to deliver their products to final consumers. This implies that the elasticity of demand for any brand is not necessarily the same across markets and, as a consequence, it is optimal to price discriminate markets. Firms in the distribution sector are perfectly competitive. They purchase home and foreign tradeable goods and distribute them in the home country using $\eta \geq 0$ units of the constant-elasticity-of-substitution basket η of nontradeable brands n:

$$\eta \equiv \left[\int_0^1 \eta\left(n\right)^{\frac{\theta_N - 1}{\theta_N}} dn\right]^{\frac{\theta_N}{\theta_N - 1}} \quad \theta_N > 1 \tag{1}$$

The parameter θ_N measures the elasticity of substitution among the different brands.

The distribution sector introduces a wedge η between wholesale and consumer prices. Denoting with $\bar{p}\left(h\right)$ and with $\bar{p}^*\left(h\right)$ the wholesale price of the generic home brand respectively in the home and foreign markets and assuming $\eta = \eta^*$ we get the consumer prices:

$$p_t(h) = \bar{p}_t(h) + \eta P_{N,t} \quad , \quad p_t^*(h) = \bar{p}_t^*(h) + \eta P_{N,t}^* \tag{2}$$

where P_N (P_N^*) is the price of the home (foreign) composite basket η. The price index P_N:

$$P_N = \left[\int_0^1 p\left(n\right)^{1-\theta_N} dn\right]^{\frac{1}{\theta_N - 1}} \tag{3}$$

is defined as the minimum expenditure necessary to buy one unit of the basket η.

The second key assumption is that prices are sticky in the currency of the buyer (LCP assumption). Each firm, when adjusting prices, has to pay a cost by purchasing the CES aggregated basket (C_H in the home market and C_H^* in the foreign market, defined later) of all the brands produced in the sector:

$$
\begin{aligned}
AC^{p}_{H,t}(h) &\equiv \frac{\kappa^{p}_{H}}{2}\left(\frac{\bar{p}_t(h)}{\bar{p}_{t-1}(h)}-1\right)^2 C_{H,t}\ \kappa^{p}_{H}\geq 0\\
AC^{p*}_{H,t}(h) &\equiv \frac{\kappa^{p*}_{H}}{2}\left(\frac{\bar{p}^*_t(h)}{\bar{p}^*_{t-1}(h)}-1\right)^2 C^*_{H,t}\ \kappa^{p*}_{H}\geq 0 \qquad (4)
\end{aligned}
$$

where κ^{p}_{H} and κ^{p*}_{H} measure the degree of nominal price rigidity.[6]

We assume that the generic firm produces its tradeable brand using the following CES technology:

$$
\begin{aligned}
y_t(h)+y^*_t(h) &= Z_{H,t}L_{H,t}(h) \qquad (5)\\
L_{H,t}(h) &\equiv \left[\int_0^1 L_{H,t}(h,j)^{\frac{\theta_L-1}{\theta_L}}\,dj\right]^{\frac{\theta_L}{\theta_L-1}} \qquad \theta_L>1
\end{aligned}
$$

where $L_{H,t}(h,j)$ is the labor input supplied by the generic domestic agent $j\in(0,1)$, θ_L is the elasticity of substitution between labor varieties and $y_t(h)$ and $y^*_t(h)$ the output sold respectively in the home and foreign markets.[7] The term $Z_{H,t}$ is a sector-specific technology shock that follows a stationary autoregressive process of the form:

$$
\ln Z_{H,t}=\rho_H \ln Z_{H,t-1}+\epsilon_{Z_{H,t}}
$$

where $0<\rho_H<1$ and the innovation ϵ_{Z_H} is an identically independently distributed (i.i.d.) normal variable with mean and variance equal respectively to 0 and σ^2_H.[8] Firms take wages as given when minimizing their production cost. The implied marginal cost is:

$$
MC_{H,t}=\frac{W_t}{Z_{H,t}} \qquad (6)
$$

where the wage index of the economy is defined as $W_t=\left[\int_0^1 W_t(j)^{1-\theta_L}\,dj\right]^{\frac{1}{1-\theta_L}}$. Wages are set by households who are monopolistic competitive in the labor market (see later). Concerning optimal prices, in each period the firm producing the brand h chooses $\bar{p}_t(h)$ and $\bar{p}^*_t(h)$ to maximize the expected flow of profits:

$$
E_t\sum_{\tau=t}^{\infty}\Lambda_{t,\tau}\left[\bar{p}_\tau(h)\,y_\tau(h)+S_\tau\bar{p}^*_\tau(h)\,y^*_\tau(h)-MC_{H,\tau}\left(y_\tau(h)+y^*_\tau(h)\right)\right]
$$

[6] See Rotemberg (1982) and Dedola and Leduc (2001).

[7] The implied demand of labor variety j is

$$
L_{H,t}(h,j)=\left(\frac{W_t(j)}{W_t}\right)^{-\theta_L}L_{H,t}(h)
$$

[8] In the foreign country, the corresponding law of motion is:

$$
\ln Z^*_{F,t}=\rho^*_F\ln Z^*_{F,t-1}+\epsilon^*_{Z_{F,t}}
$$

subject to price adjustment costs (4) and standard demand constraints. The term E_t denotes the expectation operator conditional on the information set at time t and $\Lambda_{t,\tau}$ is the households' intertemporal marginal rate of substitution in consumption (defined later). The nominal exchange rate S is expressed as the number of home currency units per unit of foreign currency. In a symmetric equilibrium $\bar{p}(h)$ is equal to the price index of the home composite tradeable $\bar{P}_{H,t}$ (defined below) and, similarly, $\bar{p}_t^*(h)$ is equal to the composite index $\bar{P}_{H,t}^*$. The first order conditions with respect to $\bar{P}_{H,t}$ and to $\bar{P}_{H,t}^*$ can be written as:

$$P_{H,t} = \theta_H \bar{P}_{H,t} - \theta_H MC_{H,t} + A_{H,t}, \quad P_{H,t}^* = \theta_H \bar{P}_{H,t}^* - \theta_H \frac{MC_{H,t}}{RS_t} + A_{H,t}^* \tag{7}$$

where $A_{H,t}$ and $A_{H,t}^*$ involve terms related to the presence of price adjustment costs and θ_H and RS_t are the elasticity of substitution between home tradeable brands and the home real exchange rate, respectively (see below). A crucial implication of international price discrimination is that at the border the nominal exchange rate pass-through into import prices is not complete $(\partial \log \bar{p}_t^*(h) / \partial \log S_t < 1)$. The higher is pass-through the more fluctuations in the nominal exchange rate are transmitted to import prices. In the limiting case, when the pass-through is complete exchange rate movements are fully transmitted. In our case, complete pass-through can happen only if there are neither distribution services ($\eta = 0$ and $\bar{P}_H = P_H$) nor nominal rigidities ($\kappa_H^{p*} = 0$). The above equations would collapse to the standard pricing rule of constant markup over marginal cost.

2.1.2 Nontradeable sector

Firms in the nontradeable sector solve a similar problem. Nontradeable goods do not need distribution services ($p_t(n) = \bar{p}_t(n)$) and the good is produced, as for tradeables, using a CES production function having labor varieties as inputs:

$$\begin{aligned} y(n) &= Z_{N,t} L_{N,t}(n) \\ L_{N,t}(n) &\equiv \left[\int_0^1 L_{N,t}(n,j)^{\frac{\theta_L - 1}{\theta_L}} dj \right]^{\frac{\theta_L}{\theta_L - 1}} \quad \theta_L > 1 \end{aligned} \tag{8}$$

Z_N is a sector specific technology shock that follows a stationary autoregressive process:

$$\ln Z_{N,t} = \rho_N \ln Z_{N,t-1} + \epsilon_{Z_{N,t}}$$

where $0 < \rho_N < 1$ and the innovation ϵ_{Z_N} is an i.i.d. normal random variable with mean and variance equal respectively to 0 and σ_N^2.

Each firm, when adjusting prices, has to pay a cost by purchasing the CES aggregated basket (C_N, defined later) of all the brands produced in the sector:

$$AC_{N,t}^p(n) \equiv \frac{\kappa_N^p}{2} \left(\frac{p_t(n)}{p_{t-1}(n)} - 1 \right)^2 C_{N,t} \quad \kappa_N^p \geq 0$$

where κ_N^p measures the degree of price stickiness. In each period, the firm producing the brand n chooses $p_t(n)$ to maximize the expected flow of profits subject to the above adjustment costs and demand constraint (that includes demand for nontradeables used in the domestic distribution sector).

In a symmetric equilibrium ($p(n) = P_N$) the first-order condition is:

$$P_{N,t}\left(1-\theta_N\right) = -\theta_N MC_{N,t} + A_{N,t} \tag{9}$$

where $A_{N,t}$ contains terms related to the presence of price adjustment costs and θ_N and $MC_{N,t} = W_t/Z_{N,t}$ are the elasticity of substitution between nontradable brands and the sector-specific marginal cost, respectively. If prices were flexible, they would be equal to a constant markup over marginal costs.

2.2 Households

There is a continuum of households which attain utility from consumption and leisure. Preferences are symmetric across countries, with the notable exception of home bias. Nominal and relative price indices are derived from them.

2.2.1 Intratemporal preferences and the real exchange rate

The aggregate consumption basket, C_t, is defined as:

$$C_t \equiv \left[a_T^{\frac{1}{\rho}} C_{T,t}{}^{\frac{\rho-1}{\rho}} + \left(1-a_T\right)^{\frac{1}{\rho}} C_{N,t}{}^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}} \quad \rho > 0 \tag{10}$$

where ρ is the elasticity of substitution, C_T is the bundle of tradeables and the parameter a_T $(0 < a_T < 1)$ is its share, C_N the basket of nontradeables.

The consumption index of traded goods C_T is:

$$C_{T,t} \equiv \left[a_H^{\frac{1}{\phi}} C_{H,t}{}^{\frac{\phi-1}{\phi}} + \left(1-a_H\right)^{\frac{1}{\phi}} C_{F,t}{}^{\frac{\phi-1}{\phi}}\right]^{\frac{\phi}{\phi-1}} \quad \phi > 0 \tag{11}$$

where the parameter ϕ is the elasticity of substitution,the parameter a_H $(0 < a_H < 1)$ is the share of domestic tradeables, C_H and C_F are the baskets of, respectively, home and foreign tradeables brands:[9]

$$\begin{aligned} C_{H,t} &\equiv \left[\int_0^1 c_t\left(h\right)^{\frac{\theta_H-1}{\theta_H}} dh\right]^{\frac{\theta_H}{\theta_H-1}}, \; C_{F,t} \equiv \left[\int_0^1 c_t\left(f\right)^{\frac{\theta_F-1}{\theta_F}} df\right]^{\frac{\theta_F}{\theta_F-1}} \\ C_{N,t} &\equiv \left[\int_0^1 c_t\left(n\right)^{\frac{\theta_N-1}{\theta_N}} dn\right]^{\frac{\theta_N}{\theta_N-1}} \end{aligned}$$

[9] C_F^* and C_H^* are similarly defined.

We assume that preferences are symmetric across countries ($a_T^* = a_T$, $\phi^* = \phi$, $\theta_H^* = \theta_H = \theta_F^* = \theta_F$, $\theta_N^* = \theta_N$) with the only exception of home bias. In each country, households have a strong preference for the domestic tradeable good ($a_H > 0.5$). Assuming symmetric home bias ($a_H^* = 1 - a_H$), the foreign consumption index of traded goods is:

$$C_{T,t}^* \equiv \left[(1 - a_H)^{\frac{1}{\phi}} C_{H,t}^{*\frac{\phi-1}{\phi}} + a_H^{\frac{1}{\phi}} C_{F,t}^{*\frac{\phi-1}{\phi}} \right]^{\frac{\phi}{\phi-1}} \tag{12}$$

Distribution services introduce a wedge between the elasticity of substitution of tradeable goods at the consumer and producer levels. The latter is given by:

$$\phi \left(1 - \eta \frac{P_N}{p(h)} \right) \tag{13}$$

where P_N and $p(h)$ are set at their steady state values. The lower elasticity of substitution at producer level contributes to increasing the volatility of relative prices and the real exchange rate. From the definition of the consumption bundles we can derive price indexes. In the home country the consumption-based price index:

$$P_t = \left[a_T P_{T,t}^{1-\rho} + (1 - a_T) P_{N,t}^{1-\rho} \right]^{\frac{1}{1-\rho}} \tag{14}$$

The price index P_T of the tradeable bundle is:[10]

$$P_{T,t} = \left[a_H P_{H,t}^{1-\phi} + (1 - a_H) P_{F,t}^{1-\phi} \right]^{\frac{1}{1-\phi}} \tag{15}$$

The symmetric home bias assumption implies the following foreign price index of tradeables:

$$P_{T,t}^* = \left[(1 - a_H) P_{H,t}^{*1-\phi} + a_H P_{F,t}^{*1-\phi} \right]^{\frac{1}{1-\phi}}. \tag{16}$$

Given the above indexes, it is possible to define the real exchange rate and the terms of trade. The first is given by:

$$RS_t = \frac{S_t P_t^*}{P_t}$$

that measures the relative price of foreign consumption in terms of home consumption. A depreciation (appreciation) of the real exchange rate corresponds to an increase (decrease) in RS. The terms of trade of the home economy at the producer and consumer levels are respectively:

$$\overline{TOT}_t = \frac{\overline{P}_{F,t}}{S_t \overline{P}_{H,t}^*}, \quad TOT_t = \frac{P_{F,t}}{S_t P_{H,t}^*}$$

and two expression differ because of distribution services at the consumer level.

[10] The price index P_H is equal to $P_{H,t} = \left[\int_0^1 p_t(h)^{1-\theta_H} dh \right]^{\frac{1}{1-\theta_H}}$. Price indexes $P_{F,t}$ and $P_{N,t}$ and their foreign counterparts are similarly defined.

2.2.2 Intertemporal preferences and financial structure

Households receive utility from consuming the basket C_t of goods and disutility from working L_t hours. The expected value of household j lifetime utility is given by:

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \xi_t \left[\frac{C_t(j)^{1-\sigma}}{1-\sigma} - \frac{\kappa}{\tau} L_t(j)^{\tau} \right] \right\}$$

where E_0 denotes the expectation conditional on information set at date 0, β is the discount factor, $1/\sigma$ is the elasticity of intertemporal substitution and $1/(\tau - 1)$ is the labor Frish elasticity. The preference shifter ξ is common to all households and follows an autoregressive process of order one:

$$\ln \xi_t = \rho_\xi \ln \xi_{t-1} + \epsilon_{\xi,t}$$

where $0 < \rho_\xi < 1$ and the innovation $\epsilon_{\xi,t}$ is an i.i.d. normal random variable with mean and variance equal, respectively, to 0 and σ_ξ^2.[11]

Households in the home country can invest their wealth in two risk-free bonds with a one-period maturity. One is denominated in domestic currency and the other in foreign currency. In contrast, foreign households can allocate their wealth only in the bond denominated in the foreign currency.[12]

The budget constraint of household j in the home country is:

$$\begin{aligned} &\frac{B_{H,t}(j)}{R_t} + \frac{S_t B_{F,t}(j)}{R_t^* \Phi(\frac{S_t B_{F,t}}{P_t} - b)\mu_t} - B_{H,t-1}(j) - S_t B_{F,t-1}(j) \\ \leq \; &\int_0^1 \Pi_t(h,j)\, dh + \int_0^1 \Pi_t(n,j)\, dn + W_t(j) L_t(j) - P_t C_t(j) - W_t AC_t^W(j) \quad (17) \end{aligned}$$

$B_H(j)$ is household holding of the one-period risk-free nominal bond, denominated in units of home currency, that pays a gross nominal interest rate R_t. $B_F(j)$ is the holding of the risk-free one-period nominal bond denominated in units of foreign currency, that pays R_t^*. Both R_t and R_t^* are paid at the beginning of period $t+1$ and are known at time t. The function $\Phi(\frac{S_t B_{F,t}}{P_t} - b)$, that captures the costs of undertaking positions in the international asset market and pins down a well-defined steady-state, has the following functional form:

$$\Phi\left(\frac{S_t B_{F,t}}{P_t} - b\right) \equiv \exp\left(\phi_b \left(\frac{S_t B_{F,t}}{P_t} - b\right)\right) \qquad \phi_B \geq 0$$

The parameter ϕ_B controls the speed of convergence to the non-stochastic steady state.[13] The payment of this cost is rebated in a lump-sum fashion to foreign agents. Households

[11] We do not include money explicitly and interpret this model as a cash-less limiting economy in the spirit of Woodford (1998).

[12] See Benigno (2001) for a similar financial structure.

[13] The function $\Phi(.)$ depends on real holdings of the foreign assets in the entire home economy. Hence, domestic households take it as given when deciding on the optimal holding of the foreign bond. We require that $\Phi(0) = 1$ and that $\Phi(.) = 1$ only if $S_t B_{F,t}/P_t = b$, where b is the steady state real holdings of the foreign assets in the entire home economy. The function $\Phi(.)$ is assumed to be differentiable and decreasing at least in the neighborhood of the steady state. See Turnovsky (1985) and Schmitt-Grohé and Uribe (2003).

derive income from two sources: nominal wage income $W_t(j) L_t(j)$ and profits of domestic tradeable and nontradeable firms, respectively $\int_0^1 \Pi_t(h)\, dh$ and $\int_0^1 \Pi_t(n)\, dn$. Each household is a monopolistic supplier of one type of labor $L_t(j)$ and sets the nominal wage $W_t(j)$ taking into account the demand for her type of labor by domestic firms. Wage setting is subject to quadratic adjustment costs which are measured in terms of the total wage bill:

$$AC_t^W(j) \equiv \frac{\kappa_W}{2}\left(\frac{W_t(j)}{W_{t-1}(j)} - 1\right)^2 L_t \qquad \kappa_W > 0 \tag{18}$$

where the parameter κ_W measures the degree of nominal wage rigidity.

The first order conditions with respect to $B_{H,t}(j)$ and $B_{F,t}(j)$ are:

$$C_t^{-\sigma}(j)\,\xi_t = R_t \beta E_t\left[C_{t+1}^{-\sigma}(j)\,\xi_{t+1}\frac{P_t}{P_{t+1}}\right] \tag{19}$$

$$C_t^{-\sigma}(j)\,\xi_t = R_t^* \Phi\left(\frac{S_t B_{F,t}}{P_t} - b\right)\mu_t E_t\left[C_{t+1}^{-\sigma}(j)\,\xi_{t+1}\frac{P_t}{P_{t+1}}\frac{S_{t+1}}{S_t}\right] \tag{20}$$

Combination of the log-linearized versions of the two above equations yields the following modified UIRP condition:[14]

$$\hat{R}_t - \left(\hat{R}_t^* - \phi_b b_{F,t}\right) - \hat{\mu}_t = \widehat{\Delta S}_{t+1} \tag{21}$$

where $\widehat{\Delta S} > 0$ is depreciation rate of the nominal exchange rate, $Yb_{F,t} \equiv (S_t B_{F,t}/P_t - b)$ where Y is the steady state value of total home output. The shock μ_t follows an AR(1) process:

$$\ln \mu_t = \rho_\mu \ln \mu_{t-1} + \epsilon_{\mu,t}$$

where $0 < \rho_\mu < 1$ and the innovation ϵ_μ is an i.i.d. normal random variable with mean and variance equal respectively to 0 and σ_μ^2. The shock can be justified on the basis of the well known weak empirical support in favour of the uncovered interest parity condition. From a theoretical point of view, it can be seen as one shortcut for "noise traders" that have biased expectations on the exchange rate or for "information shocks" that affect the risk premia required by foreign-exchange markets.[15]

The assumption of incomplete international financial markets is crucial for fitting the real exchange rate dynamics. When a complete set of state contingent nominal assets is traded the following log-linearized risk-sharing condition holds in every state of nature:

$$\widehat{RS}_t = \sigma(\hat{C}_t(j) - \hat{C}_t^*(j)) \tag{22}$$

according to which the real exchange rate is proportional to the relative marginal utilities of consumption, and hence, given the specification of preferences we adopt, to the relative consumption. The drawback is that it is hard to replicate the exchange rate volatility without assuming a sufficiently high level of the coefficient of risk aversion σ (i.e., a relatively low intertemporal elasticity of substitution). To weak the risk-sharing condition

[14] Variables are defined as $\hat{X}_t = lnX_t - ln\bar{X}$, where $ln\bar{X}$ is the steady-state value.

[15] See Devereux and Engel (2002) and Duarte and Stockman (2005).

we assume incomplete international financial markets. In this case the relation between the real exchange rate and the marginal utilities holds only in expected values. Hence, expectations introduce a wedge between relative consumption and real exchange rate. Combining the home and foreign agent's log-linearized first order conditions with respect to the internationally traded bond $B_{F,t}$ gives:

$$\begin{aligned} E_t\left(\widehat{RS}_{t+1}-\widehat{RS}_t\right) &= E_t\left[\sigma\left(\hat{C}_{t+1}(j)-\hat{C}_t(j)\right)-(\xi_{t+1}-\xi_t)\right]- \\ &\quad E_t\left[\sigma(\hat{C}^*_{t+1}(j)-\hat{C}^*_t(j))-\left(\xi^*_{t+1}-\xi^*_t\right)\right]+\phi_B b_{F,t}-\hat{\mu}_t \end{aligned} \tag{23}$$

The assumption of incomplete markets has two other advantages. First, shocks lead to wealth redistribution across countries and hence increase in the persistence of the real exchange rate. Second, under risk sharing, the correlation between real exchange rate and relative consumption is, counterfactually, positive (Backus-Smith puzzle).[16] This is not necessarily the case under incomplete markets: since the international bond is traded only after shocks are realized the above equation does not necessarily hold in the first period. Consequently, the correlation between real exchange rate and relative consumption can be negative, in line with the empirical evidence. The preference shocks ξ_t and ξ^*_t and the UIRP shock also contribute to break the link between real exchange rate and relative marginal utility.[17]

Finally, the first order condition with respect to wages is:

$$\frac{W_t(j)}{P_t}=A_{W,t}\frac{\theta_L}{(\theta_L-1)}\kappa L_t^{\tau-1}(j)\frac{C_t^{\sigma}(j)}{\xi_t} \tag{24}$$

The real wage is equal to the marginal rate of substitution between consumption and leisure times the term $\theta_L/(\theta_L-1)$, which measures the markup in the labour market and a term that takes into account the adjustment costs, $A_{W,t}$. Absent these costs, the real wage would be equal to a constant markup over the marginal rate of substitution between consumption and leisure.

2.3 Monetary policy

Home monetary authority sets the short-term nominal interest according to the following log-linear feedback rule:

$$\hat{R}_t=\rho_R\hat{R}_{t-1}+(1-\rho_R)\rho_\pi\hat{\pi}_t+(1-\rho_R)\rho_y\hat{y}_t+(1-\rho_R)\rho_s\widehat{\Delta S}_t+\varepsilon_t \tag{25}$$

where $\hat{R}_t$ is the short-term nominal interest rate, $\hat{\pi}_t$ is the consumer price inflation rate, $\hat{y}_t$ is obtained by log-linearizing the sum of home tradable and nontradable output around the steady state (see below) and $\widehat{\Delta S}$ is the nominal exchange rate percent variation ($\widehat{\Delta S}>0$ is a depreciation). The parameter ρ_R ($0<\rho_R<1$) captures inertia in interest rate setting. The monetary policy shock is denoted with ε_t and follows an i.i.d. normal process with mean and variance equal respectively to 0 and σ_R^2. A similar monetary policy function holds in the foreign country.

[16] See Backus and Smith (1993).

[17] Stockman and Tesar (1995) also consider preference shocks.

2.4 Market clearing conditions

Market clearing conditions are defined as:

$$\begin{aligned} y_t(h) &= a_H a_T \left(\frac{p_t(h)}{P_{H,t}}\right)^{-\theta_H} \left(\frac{P_{H,t}}{P_{T,t}}\right)^{-\phi} \left(\frac{P_{T,t}}{P_t}\right)^{-\rho} \int_0^1 C_t(j)\, dj \qquad (26) \\ &+ \left(\frac{\bar{p}_t(h)}{\bar{P}_{H,t}}\right)^{-\theta_H} \int_0^1 AC_{H,t}(x)\, dx \\ y_t^*(h) &= (1-a_H) a_T \left(\frac{p_t^*(h)}{P_{H,t}^*}\right)^{-\theta_H} \left(\frac{P_{H,t}^*}{P_{T,t}^*}\right)^{-\phi} \left(\frac{P_{T,t}^*}{P_t^*}\right)^{-\rho} \int_0^1 C_t(j^*)\, dj^* \qquad (27) \\ &+ \left(\frac{\bar{p}_t^*(h)}{\bar{P}_{H,t}^*}\right)^{-\theta_H} \int_0^1 AC_{H,t}^*(x)\, dx \\ y_t(f) &= (1-a_H) a_T \left(\frac{p_t(f)}{P_{F,t}}\right)^{-\theta_H} \left(\frac{P_{F,t}}{P_{T,t}}\right)^{-\phi} \left(\frac{P_{T,t}}{P_t}\right)^{-\rho} \int_0^1 C_t(j)\, dj \qquad (28) \\ &+ \left(\frac{\bar{p}_t(f)}{\bar{P}_{F,t}}\right)^{-\theta_H} \int_0^1 AC_{F,t}(x)\, dx \\ y_t(n) &= (1-a_T) \left(\frac{p_t(n)}{P_{N,t}}\right)^{-\theta_N} \left(\frac{P_{N,t}}{P_t}\right)^{-\rho} \int_0^1 C_t(j)\, dj \qquad (29) \\ &+ \left(\frac{p_t(n)}{P_{N,t}}\right)^{-\theta_N} \eta \left(\int_0^1 C_{H,t}(j)\, dj + \int_0^1 C_{F,t}(j)\, dj\right) \\ &+ \left(\frac{p_t(n)}{P_{N,t}}\right)^{-\theta_N} \int_0^1 AC_{N,t}(x)\, dx \end{aligned}$$

The firs two equations are the market clearing conditions of the generic home tradeable brand h in the home and foreign market, respectively. The third equation is the clearing condition of home imports of the generic brand f produced in the foreign country. The last one is the condition of home nontradable goods, that are bought by the domestic households and distribution sector. In each market clearing there is also the demand component implied by the price adjustment costs of firms x. As for financial markets, the following market clearing conditions hold:

$$\int_0^1 B_{H,t}(j)\, dj = 0, \quad \int_0^1 B_{F,t}(j)\, dj + \int_0^1 B_{F,t}^*(j^*)\, dj^* = 0. \qquad (30)$$

The market clearing condition of the labor variety supplied by agent j is:

$$L_t(j) = \left(\frac{W_t(j)}{W_t}\right)^{-\theta_L} \int_0^1 L_{H,t}(h)\, dh + \int_0^1 L_{N,t}(n)\, dn$$

From the budget constraint (17) and the above conditions we can derive the following equation for the home trade balance:

$$
\begin{aligned}
TB_t &= \frac{\int_0^1 S_t B_{F,t}(j)\,dj}{R_t^* \Phi(\frac{S_t B_{F,t}}{P_t})\mu_t} - \int_0^1 S_t B_{F,t-1}(j)\,dj \\
&= S_t \int_0^1 \bar{p}_t^*(h)\, y_t^*(h)\, dh - \int_0^1 \bar{p}_t(f)\, y_t(f)\, df \qquad (31)
\end{aligned}
$$

which is equal to the difference between total export and import.

2.5 Equilibrium

We make two assumptions. First, firms belonging to the same sector set the same price (hence $\bar{p}_t(h) = \bar{P}_{H,t}$, $\bar{p}_t^*(h) = \bar{P}_{H,t}^*$ and $p_t(n) = P_{N,t}$). Second, households belonging to the same country have the same initial level of wealth and share the profits of domestic firms in equal proportion. Hence, within a country all the households face the same budget constraint. In their optimal decisions, they will choose the same path of bonds, consumption and wages. The equilibrium is a sequence of allocations and prices such that, given the initial conditions, in each country the representative agent and the representative firms satisfy their respective first order conditions and the market clearing conditions hold.

Since a closed form solution is not possible, the behaviour of the economy is studied by taking at a loglinear approximation to the model equations in the neighbourhood of a deterministic steady state. In this steady state shocks are set to their mean values, price inflation, wage inflation and the exchange rate depreciation are set to zero, interest rates are equal to the agents' discount rate, consumption is equalized across countries, the trade balance and the net foreign asset position are zero. Given the presence of distribution costs, the price of nontradeables is different from that of tradeables. However, prices are symmetric between countries and the real exchange rate is one.

3 Bayesian estimation

In this Section we first presents the results of the estimation and then we assess the fit of the model by computing in-sample prediction errors for the observables and simulating second moments.

3.1 Data

We interpret the model as representing the euro area and the U.S. economies. The home country is the euro area. In estimating the model we use data for the period 1983:1-2005:2 on 14 variables: real consumptions C and C^*, consumer prices inflation rates π and π^*, nontradeable inflation rates π_N and π_N^*, domestic tradeable inflation rates $\bar{\pi}_H$ and $\bar{\pi}_F^*$, wage inflation rates π_W and π_W^*, the euro-dollar real exchange rate RS and the trade balance TB. Inflation rates are constructed as quarterly changes in the corresponding price indexes. We use the inflation rate in the manufacturing and services sector for, respectively, domestic tradeables and for nontradeables. The real exchange rate is based on consumer price indices. The trade balance series is the bilateral net export series between the U.S. and the euro area. More details on data can be found in the Appendix.

3.2 Prior distributions and calibrated parameters

The Bayesian estimation technique allows us to use the prior information from earlier micro and macro studies. In particular, we choose priors as close as possible to those of Adolfson *et al.* (2007), Lubik and Schorfheide (2005) and Rabanal and Tuesta (2006). We use the beta distribution for all parameters between 0 and 1, the gamma for those bounded on the set of positive numbers and the normal for the unbounded ones. We assume all distributions to be *a priori* independent. Table 1 reports the mean and standard deviation of these distributions.

Priors on preferences are standard. The mean of home bias, a_H, is set at 0.95 (standard deviation 0.1) and the mean of the share of tradeables, a_T, at 0.45 (0.1).[18] The mean of intratemporal elasticity of substitution between home and foreign tradeables, ϕ, is set at 1.14 (0.1), while that of intratemporal elasticity of substitution between tradeables and non tradeables, ρ, at 0.74 (0.1).[19] The mean of the risk aversion coefficient, σ, is set at 2.0 (0.2). The elasticity of the net foreign asset position to the premium, ϕ_b, has a mean equal to 0.01.

As far as the coefficients of monetary policy rules are concerned, we chose standard values for their prior distributions: a relatively high mean, 1.5, on the inflation coefficients ρ_π and ρ_π^* (standard deviation 0.1) helps to guarantee a unique solution of the model. The means of the coefficients on the lag of the interest rate, ρ_R and ρ_R^*, are set at 0.8 (standard deviation 0.1), those of the output coefficients, ρ_y and ρ_y^*, and exchange rate depreciation coefficients, ρ_s and ρ_s^*, respectively at 0.1 and 0 (in all cases, the standard deviation is 0.1).

Parameters measuring price stickiness (k_i and k_i^*, with $i = H, F, N, N^*$) have the same mean value, set at 5.6 (standard deviation 10). This value is consistent with micro evidence of Bils and Klenow (2002) for the U.S. and by Fabiani *et al.* (2005) for the euro area. Parameters measuring wage stickiness (k_W and k_W^*), which are chosen on the basis of the results by Smets and Wouters (2005), have a mean value equal to 63 (standard deviation 40), that corresponds to an average contract length of 5 quarters. We set the mean of the parameter η of distribution services at 1.2 (0.1).[20]

The autoregressive parameters of shocks have a mean value set at 0.9 (standard devi-

[18] Stockman and Tesar (1995) find that a_N is around 0.5 for the major OECD countries. Corsetti *et al.* (2005) calibrate a_H to 0.72.

[19] Corsetti *et al.* (2005) calibrate ρ at 0.74, consistently with empirical evidence in Mendoza (1991), while Bergin (2004) estimate for ϕ is equal to 1.13.

[20] Corsetti *et al.* (2005), following Burstein *et al.* (2003) set η to a value that matches the share of the retail price of tradables accounted for by the local distribution services in the U.S. (approximately 50 percent).

ation is 0.05). The standard deviations of all shocks have a prior mean equal to 0.01.

A very small number of parameters is calibrated.[21] The discount factor β is set at 0.99. The Frish labor elasticity, $1/(\tau - 1)$, is set at 1. The elasticity of substitution between labour varieties, θ_W, is set at 4.3. The elasticity of substitution between nontradeable varieties, θ_N, is set at 6 while the elasticity between tradeable varieties, θ_H, is endogenously set to satisfy the equality $\theta_H = \theta_N (1 + \eta)$, which assures that markups are equal across sectors. The prior mean of η and the value of θ_N imply that θ_H is equal to 13.2. These values are similar to those used by Corsetti *et al.* (2005).

3.3 Posterior distributions

The technical details of the Bayesian estimation procedure are provided in the Appendix. In the following we comment on some features of the estimated posterior distributions of the parameters, and also try to ascertain whether the data were informative or not about our parameters, by comparing marginal priors and marginal posteriors. Table 1 reports some percentiles from the posteriors ($2.5th$, $50th$ and $97.5th$) as well as mean and standard deviations of priors and posteriors. A look at the table suggests that our data were informative about home bias a_H, whose posterior mean and median (0.92) are lower than the prior mean.[22] Data are also informative on the share of tradeables in the consumption basket a_T. Prior and posterior means are similar, but the posterior variance is lower than its prior counterpart. The posterior mean of the consumer elasticity of substitution between tradeables ϕ is higher (1.47) than the prior mean (1.14). Estimation drives the mean of η to 1.0, only marginally below the mean of the prior. The previous two estimates imply that the mean of the elasticity of substitution between tradeables at producer level is 0.7. Data are not informative about the degree of substitutability between tradeables and nontradeables ρ and the coefficient of relative risk aversion σ.[23]

In order to comment on the parameters measuring the degrees of price stickyness and to allow for a better comparison with other empirical analyses, it is useful to transform them into probability of not adjusting prices and frequency of adjustments. Table 2, which reports these results, suggests that in each country wages are the most rigid prices, followed by those of nontradeables and tradeables. As we'll see, these two features allow fitting the real exchange rate and the inflation rates without the need of having extremely high values of import price stickiness or home bias to insulate stable domestic nominal prices from highly volatile international relative prices.[24] Overall, the results are consistent

[21] Calibration can be seen as chosing a prior with infinite precision.

[22] Estimates in the literature are quite similar. Rabanal and Tuesta (2006) report, depending on the estimated model, 0.92 and 0.98, Lubik and Schorfheide (2005) equal to 0.8 and 0.9.

[23] Lubik and Schorfheide (2005) estimate a posterior mean value of σ slightly below 4.0. Rabanal and Tuesta (2006) assume log utility.

[24] Rabanal and Tuesta (2006) find that firms adjust prices once every 4 and 5 quarters respectively in the euro area and in the U.S., Lubik and Schorfheide (2005) find values between 1 and 7 quarters for import prices, depending on the estimated model. Eichenbaum and Fisher (2005) find that U.S. firms reoptimize prices at least once every two quarters. Adolfson *et al.* (2007) find that import prices adjust once every 2-3 quarters in the euro area. Ortega and Rebei (2006) use Canadian data to estimate a small open *NOEM* economy model with, as in our case, sticky wages and nontradables. Their estimates are

with much of the evidence based on microdata, which suggests that the main source of stickiness in the industrialized economies are not prices, but wages. Obstfeld and Rogoff (2000) emphasize this point when they say that models of incomplete pass-through based only on high import price rigidities hardly replicate the positive correlation between terms of trade and real exchange rate. In the next section we show that our model is able to replicate this stylized fact.

The parameters of the monetary policy rules are rather similar in the two countries. Both rules are relatively inertial and aggressive against inflation, while there seems not to be a significant reaction to exchange rate fluctuations. The high inertia contributes to the fit of the observables by increasing the endogenous persistence of the model.[25] The estimates of the autoregressive coefficients of the shock processes are high, but not extremely so. The more persistent shocks are those to the UIRP condition, to the technology of the euro area nontradeables and of the U.S. economy. The data are not informative about the persistence of the shock to the technology of the euro area tradeables and to U.S. preferences.

Finally, we find that the adjustment cost of the net foreign asset position, ϕ_b, is around 0.01, in line with estimates of Rabanal and Tuesta (2006).

3.4 Model fit

Following Adolfson *et al.* (2007) in Figure 1 we assess the fit of the model by computing the Kalman filtered one-sided estimates (thick line) of the observed variables at the posterior mode and comparing them with the actual data (thin lines). The fit of the real exchange rate, consumption levels, interest rates and inflation rates is satisfactory. The model faces some difficulty in fitting nominal wage inflation rates and the bilateral trade balance, that in the data are more volatile than predicted in the model. However, these two variables are likely to be measured with large errors.

We also assess the explanatory power of the model by simulating second moments and comparing them with those in the data. To this end we draw 500 vectors of parameters from their posterior distribution and for each of them we generate 100 times series for the main variables. Each of them is 292 periods long. We discard the first 200 observations to work with a number of periods equal to that of the actual series. Their business cycle component is extracted using the Hodrick-Prescott (HP) filter. Statistics are computed using all the simulated time series. Table 3 reports the 2.5, 50, 97.5 percentiles of the standard deviation and first order autocorrelation. The volatility of the real exchange rate is higher in the data (8.40) than in the model (95% of the posterior distribution lies between 4.84 and 8.58), confirming the well-known difficulty in replicating the high volatility of international relative prices. However, the magnitudes of actual and simulated volatilities are not too different. At the same time, the model is able to replicate the volatility of

close to ours: Canadian import have a posterior median duration of two quarters, nontradeables of three quarters, wages of five quarters.

[25] See Benigno (2004) for the role of inertial monetary policy rules in matching the high persistence of the real exchange rate.

the fundamentals, which is much lower than that of the real exchange rate, both in the model and in the data.[26] The model has a hard time in matching the persistence of the real exchange rate (0.66 the posterior median of the autocorrelation coefficient), coming slightly below the value in the data (0.81). Regarding other observables, the persistence of the CPI inflations (π and π^*), and U.S. domestic tradable prices ($\bar{\pi}_F^*$) as well as that of euro area nominal interest rate (R) is relatively well matched. The persistence of other inflation rates (euro area and U.S. nontradable prices, i.e. π_N and π_N^*) is overstated, that of consumptions (C and C^*) is instead underestimated.

Table 4 reports cross-correlations. The model replicates the low cross-correlation between real exchange rate, the various inflation rates, nominal interest rates and the levels of home and foreign consumption (disconnect). Hence, the large and volatile fluctuations of the real exchange rate are not transmitted to nominal prices. Consumer relative prices, interest rates and consumptions do not greatly vary. As we show in the next session, nontradables and home bias are mainly responsible for matching these moments. The model is also able to replicate the correlations of the real exchange rate with relative consumption (the so-called Backus-Smith puzzle), the countercyclical behavior of the trade balance (cross correlation between trade balance and euro area consumption) and the negative cross-correlation of consumptions.

The overall message is that the model is able to account sufficiently well for the dynamics of the data and, thus, can be used in the next Section to understand which features contribute to the real exchange rate disconnect.

4 What explains the real exchange rate volatility and disconnect

In this Section we investigate the role of the various features in accounting for the disconnect. As a starting point, we decompose the variance of the change in the real exchange rate on the basis of the following equation (obtained by log-differencing the real exchange rate and consumer price definitions):

$$\begin{aligned}\Delta RS_t = (1-a_T)(\pi_{N,t}^* - \pi_{T,t}^*) - (1-a_T)(\pi_{N,t} - \pi_{T,t}) + \cdots \\ +(2a_H - 1)(\pi_{F,t} - \pi_{H,t}) + \cdots \\ +a_H\left(\Delta S_t + \pi_{F,t}^* - \pi_{F,t}\right) + (1-a_H)\left(\Delta S_t + \pi_{H,t}^* - \pi_{H,t}\right)\end{aligned} \tag{32}$$

where ΔRS_t and ΔS_t are the percentage change in the real and nominal exchange rate between period t and $t-1$, $\pi_{T,t}$, $\pi_{H,t}$, $\pi_{F,t}$, $\pi_{N,t}$ denote the home country inflation rates of respectively tradeable, home tradeable, foreign tradeable and nontradeable goods. Variables with a star refer to their foreign counterparts. The first two terms in equation (32) are referred to as the "real internal real exchange rate"while the term in the second row is

[26] The volatility of the CPI inflation rate is matched in the euro area, underestimated in the U.S. Nontradables inflation rates and consumption volatilities are instead matched. As for nominal interest rates, the model matches the euro area data, while understates the volatility of U.S. data.

captures the role of home-bias. Finally, the last two terms show the deviations from the international law of one price for, respectively, the foreign and home tradeables. Absent non tradeable goods ($a_T = 1$), home bias ($a_H = \frac{1}{2}$) and assuming that the law of one price holds (there is no market segmentation $\Delta S_t + \pi^*_{F,t} = \pi_{F,t}$ and $\Delta S_t + \pi^*_{H,t} = \pi_{H,t}$), the purchasing power parity would hold and the real exchange rate would be constant. Variances and covariance terms are obtained by simulation as described in the previous section. The results, which are reported in Table 5, suggest that international price discrimination is an important source of the real exchange fluctuations, followed by home bias. The contribution of the internal real exchange rate is negligible, indicating that the relative price of nontradeables does not matter for real exchange rate fluctuations. However, the role of nontradables for real exchange rate fluctuations cannot be dismissed since they are an important source of international pricing discrimination.

Figure 2 reports the decomposition of the actual real exchange rate based on equation (32) and the mean of the posterior distribution of the parameters a_T and a_H. The graph confirms that international price discrimination and home bias play a crucial role in shaping the dynamics of the real exchange rate as it can be seen by the fact that these components track pretty well its time series.

To further assess the importance of nontradeables, home bias and international price discrimination we estimate variants of the benchmark model that differ for the features that we include. The columns of Table 6 report the mode of parameter vector (and the marginal likelihood) of the following models: i) without nontradeables (no NT); ii) without home bias (no HB); iii) without price discrimination and with prices set in the producer currency (producer currency assumption, PCP); iv) without distribution services (i.e. setting $\eta = 0$) and with LCP being the only source of international price discrimination (LCP); v) without the UIRP shock. For comparison purposes the mode of the benchmark model (LCP-DC) is also reported in the first column.

The comparison between the first and second column shows that, absent nontradeables, the mode of home bias a_H approaches one. In this case the model fits the observables by closing the two economies and thus letting the coincidence between consumer and domestic tradeable prices to insulate consumers from real exchange rate fluctuations. When there is no home bias (a_H is calibrated at 0.5, see the third column), the share of nontradables ($1 - a_T$) increase to one, so as to close the two economies in a way similar to the case of no nontradables (no NT); in each country domestic nontradeables and consumer prices coincide, insulating the latter from the instability of international relative prices. The PCP column shows the implications of (the absence of) price discrimination. Under this assumption, the international law of one price holds and pass-through of exchange rate onto import price is complete. Higher values of home bias a_H and share of nontradeables ($1 - a_T$) allow fitting both fundamentals and the real exchange rate, so to compensate for the lack of international price discrimination and its insulating properties. A similar message comes out from the next to the last column, that shows estimates when there is no distribution sector. In this case the distinction between wholesale and retailing prices does not hold and local currency pricing is the only source of international price discrimination. To fit the observables, home bias, share of nontradeables (as in the PCP) and import prices nominal rigidities, all increase. The LCP and PCP models, given the absence of the distribution sector, cannot rely upon a low elasticity of substitution between tradeables at the producer level (given by $\phi\left(1-\eta\frac{P_N}{P_H}\right)$, see equation (13)) to improve the fit. Hence, they exploit the insulating properties of home bias, nontradables and price stickiness. Finally, when the UIRP shock is not in the model, the share of tradeables increases, while the degree of import price rigidity goes down. This model is not able to replicate the high volatility of the real exchange (see below)[27], and hence has no need to insulate the real side of the economy using nontradeables or import price stickiness. Note also that the model's fit is relatively low. Overall, the results of the sensitivity analysis presented in Table 6 suggests that nontradeables, price discrimination and UIRP shock are key features to fit our observables and in particular the real exchange rate.

To draw further evidence about the role of the various features in matching the data, we also computed the marginal likelihood of the model, a measure of aggregate fit that is obtained by integrating the posterior density over the parameter set.[28] The resulting number is a summary statistic measuring the probability of having observed the data under the proposed model independently of any particular parameter configuration. The last row of Table 6 presents the marginal likelihood for a set of alternative specifications of our model (to be discussed in the next session) with the "benchmark" model discussed so far in the LCP-DC column. Although, according to this criterion, the LCP model (where we shut down the distribution sectors by setting $\eta = 0$) produces the best fit (better: the highest marginal likelihood), the benchmark model is among the best fitters and, more importantly, there is a strong deterioration in the fitting ability of any model lacking home bias, a shock to the UIRP and/or nontradable goods, suggesting that these features are crucial for the empirical fit of our dataset.[29]

We further investigate this result by turning off these features one at a time and using the median of the posterior distribution of the benchmark model to simulate the second moments. The results are reported in Tables 7-9.[30] Each of the features contributes to the real exchange rate volatility, in particular distribution services, home bias and nontradeables (Table 7). Distribution services and nontradeables are also important to match the volatility of the fundamentals. The volatilities of inflation rates, interest rates and consumptions are larger when the nontradeables channel is shut down. Similarly, distribution services allow matching the volatility of CPI and tradeables inflation rates. The latter indeed increases when η is set to zero. No single feature plays a predominant role in affecting the persistence of the observables (Table 8). Simulated values are rather similar across the various model specifications. We'll see below that exogenous shocks

[27] The measurement error of the real exchange rate, not reported, is much higher than in the LCP-DC model.

[28] The marginal likelihood is numerically computed using the modified harmonic estimator in Geweke (1999) and 300,000 draws from the Metropolis algorithm.

[29] To guarantee a fair comparison, the marginal likelihood of the LCP-noNT model is compared with the "concentrated" marginal likelihood of the LCP-DC. This statistics is obtained by fitting the LCP-DC model to all the observables with the exception of nontradeables inflation rates. The LCP-noNT model fits slightly better this reduced set of observables. The "cost" to pay, however, is the home bias equal to one.

[30] The no-NT case is obtained by setting aT, the weight of tradable goods in the consumption bundle, close to one.

play a key role in replicating first order autocorrelations. Cross-correlations between the exchange rate and fundamentals, in particular inflation rates and consumptions, increase when home bias is switched off (Table 9). The remaining specifications have similar implications. As expected, the model with only tradable goods does not replicate the cross-correlation between real exchange rate and nontradeables inflation rates.

The next step is to understand the role of each shocks in explaining the dynamics of the real exchange rate. To this end, we simulate the LCP-DC model assuming: (a) only UIRP shocks; (b) shocks to the UIRP and to technology; (c) shocks to UIRP, technology and monetary; (d) shocks to UIRP, technology, monetary and preferences. The results are reported in Tables 10-12. UIRP shocks are clearly necessary to generate high volatility in the real exchange rate (Table 10). However, they do not reproduce the volatilities of fundamentals, for which fundamental shocks are necessary. In particular, technology shocks match the inflation rates volatilities, preference shocks match the consumptions volatilities. Monetary shocks allow matching the volatilities of interest rates. The UIRP shocks play also a significant role in matching the persistence of the real exchange rate (Table 11), while the contribution of other shocks is negligible. Technology and monetary policy shocks improve the matching of the persistence of, respectively, interest rates and U.S. inflation rates. Preferences play only a marginal role. Finally, Table 12 shows how the different shocks contribute to the real exchange rate disconnect. Technology shocks play the largest role while monetary shocks improve the matching of the cross-correlations of euro area consumption on one side and real exchange and trade balance on the other. Preference shocks help matching the cross-correlations between consumptions and between consumptions and real exchange rate (Backus-Smith puzzle).[31] Either shocks to the UIRP condition or shocks to preferences are needed to match this stylised fact.

Overall, the analysis suggests that home bias, distribution services, nontradeables and UIRP shocks are key features of a model that aims to match the real exchange rate volatility and its disconnect. Without these features and shocks, the volatility would be too low. Distribution services and nontradeable goods contribute to match the volatility of the fundamentals. The UIRP shock is important to induce persistence in the real exchange rate. Finally, home bias and technology shocks reduce the cross-correlations between the real exchange rate and fundamentals, thus allowing the model to replicate the disconnect. These results are similar to those in Devereux and Engel (2002). The main improvement to those authors' analysis is that our assessment of the role of the different features and shocks is based on an estimated model that has proved to be able to replicate the main empirical facts concerning the real exchange rate and its determinants.

5 Impulse responses and variance decomposition

In this Section we document the dynamic properties of our estimated economies (by showing the impulse responses), and study the relative importance of different shocks

[31] Chari *et al.* (2002) show that a two country model is able to replicate the volatility and persistence of the exchange rate with only monetary shocks only when the coefficient of risk aversion is relatively large. They also show that the model is not able to replicate the Backus-Smith puzzle.

(by reporting the variance decomposition). Figures 3 and 5 to 7 report the median and the 0.95 probability interval at each step of the impulse horizon. The percentiles are computed using the draws from the posterior distribution of the parameters from the Metropolis algorithm. The variance decomposition (Table 13) is computed on the basis of the median of the posterior distribution.

Figure 3 reports the responses of inflation rates, consumption levels and the interest rates to a positive one standard deviation UIRP shock. The strong increase in the euro area import price inflation does not translates into an equally large increase in the euro area CPI inflation rate (the same is true for the U.S.). The high values of the home bias and the share of nontradables allow to disconnect consumer prices from the large movements of the real exchange rate. The shock induces a decrease in consumption and a deterioration of the euro area terms of trade. As a consequence, through a standard substitution effect, there is a shift of world demand towards the euro area tradable goods. The decrease in the euro area interest rate is hardly significant. Similarly, the responses of U.S. consumption and interest rate are smaller than the response of import prices. All these responses can be used to study the implications of distribution services for the exchange rate pass-through. Figure 4 reports the median of the pass-through coefficients, both at the border and at the consumer level for the benchmark, the LCP and the PCP model.[32] Import prices increase in the euro area while they decrease in the U.S. economy. The magnitude of the variation is roughly one half of the impact response of the exchange rate, implying a pass-through at the border of 0.5 both in the euro area and the U.S. economy. These values are sufficiently high to guarantee a deterioration of the terms of trade in line with the results of Choudhri et al.(2005) and the empirical evidence reported by Obstfeld and Rogoff (2000). At the consumer level, given the presence of distribution services, the response of terms of trade is negative consistently with the low degree of pass-through which on impact is equal to 0.25 in both economies.

Figure 5 reports the responses to a positive one standard deviation preference shock in the euro area. The positive response of consumption induces an increase in domestic CPI inflation and the interest rate. The latter, through the UIRP condition, determines an appreciation of the euro area real exchange rate. The large degree of price stickiness and share of nontradeables in the consumption bundle limit the response of consumer price inflation. The burden of the equilibrium adjustment, therefore, relies upon international relative prices, which are relatively flexible and whose responses become large. Note that, consistently with the disconnect, U.S. consumption, CPI inflation rate and interest rate are only slightly affected by the shock.

The responses to technology and monetary shocks in the euro area, which are reported in Figures 6 and 7, all have the expected signs. After the positive technology shock, domestic CPI inflation rate and nominal interest rate decrease, while consumption increases and the real exchange rate depreciates. After the restrictive monetary shock, the domestic inflation rate and consumption decrease and the real exchange rate appreciates. The reaction of international relative prices is stronger than that of fundamentals, as in the UIRP and preference shocks cases. However, in contrast to the UIRP shock, the difference

[32] Pass-through is measured as the ratio between the response of nominal prices in each period and the initial response of nominal exchange rate.

in the magnitude of responses between the real exchange rate and import prices, on one side, and euro area consumption and CPI inflation rate, on the other, are not large. This result is in line with those of the analysis of second moments discussed in Section 3.4 and suggests that shocks to the UIRP condition are crucial for replicating the volatility of the real exchange rate.

As a final remark, notice that the disconnect should imply that (a) shocks with important effects on key macroeconomic variables do not explain a large fraction of the variation in exchange rates, and (b) shocks that explain a sizable share of exchange rate volatility do not explain a large share of the variation in other macroeconomic variables. And the results from the asymptotic variance decomposition, reported in Table 13, support this conclusion. Each of the two economies is driven primarily by domestic shocks, in particular technology and preferences, while the real exchange rate by the shock to the UIRP condition, which accounts for more than three quarters of its variance.

6 Concluding remarks

In this paper, we have investigated the dynamics of the real exchange rate in the context of an estimated model that incorporates many features proposed in the NOEM literature. The model replicates the volatility of the real exchange rate and its disconnect with fundamentals relying on home bias, international price discrimination and shocks to the UIRP condition. Nontradeable goods also play an important role since they are relatively sticky and represent a nontrivial component of consumer prices. They also contribute to match the volatility of inflation rates and consumption levels and allow the model to replicate the real exchange rate stylized facts without resorting to extremely high (and implausible) values for the home bias (when we drop them, home bias estimates increase to one).

The presence of a distribution sector, a key feature to induce international price discrimination, allows to reduce the pass-through of exchange rate variations onto import and consumer prices. Pass-through at the border is, instead, relatively high (the degree of import price stickiness is low) and guarantees a deterioration of the terms of trade when the nominal exchange rate depreciates, consistently with the evidence in Obstfeld and Rogoff (2000).

Several extension to the model are worth mentioning. First, the accumulation of physical capital can be introduced in the model in order to enhance the propagation mechanism of the shocks. Second, the model can be estimated along the lines suggested by Corsetti *et al.* (2006), i.e. assuming alternative prior means for the elasticity of substitution between tradeables and alternative specifications for the technology processes. In this way, it will be possible to quantify the separate contributions of the wealth and substitution effects associated to changes in relative prices to the dynamics of the real exchange rate and the fundamentals. Finally, a welfare analysis could be conducted, given the extremely different implications that alternative sources of incomplete pass-through - nominal rigidities on the one hand and real frictions, such as distribution services, on the other - have for the optimal conduct of monetary policy.

Appendix: The Bayesian estimation procedure

The Bayesian approach starts form the assertion that *both* the data Y and of the parameters Θ are random variables. Starting from their joint probability distribution $P(Y,\Theta)$ one can derive the fundamental relationship between their marginal and conditional distributions known as Bayes theorem:

$$P(\Theta|Y) \propto P(Y|\Theta) * P(\Theta)$$

Reinterpreting these distributions, the Bayesian approach reduces to a procedure for combining the *a priori* information we have on the model, as summarized in the prior distributions for the parameters $P(\Theta)$, with the information that comes from the data, as summarized in the likelihood function for the observed time series $P(Y|\Theta)$. The resulting *posterior density* of the parameters $P(\Theta|Y)$ can then be used to draw statistical inference either on the parameters themselves or on any function of them or of the original data.

Sources and treatment of the data

We use quarterly data on 14 macro variables over the period 1983:1-2005:2 from the Area Wide Model (AWM) and Bureau of Economic Analysis (BEA) databases:

Variable	*Content*	*Source & Notes*
Euro area		
real consumption	National accounts def.	AWM
consumer prices	HICP	AWM
nontradeable prices	HICP service prices	AWM
domestic tradeables prices	HICP manufactured goods	AWM
wages	nominal wages	AWM
short-term interest rate	3-months nominal rate	AWM
euro-U.S. real exchange rate	nom. exch. rate deflated using CPI's	
trade balance	bilateral net trade	
U.S.		
real consumption	National accounts def.	BEA
consumer prices	CPI	BEA
nontradeable prices	service prices	BEA
domestic tradables prices	manufactured goods	BEA
wages	nominal wages	BEA
short-term interest rate	3-months nominal rate	BEA

(33)

We estimate the model in stationary form (i.e. exploiting its implications only for the log deviations from steady state, and not for the trend, of the variables) and therefore we pre-treat the data prior to estimation in order to achieve stationary. We demeaned all inflation rates, the interest rates and the real exchange rate; we remove a linear trend from the real consumptions, and a quadratic trend from the trade balance series.[33]

The series for tradeable inflation in the euro area has a strong seasonal component starting from 2001:1 (due to a change in the methodology and composition of the underlying data). We removed the resulting structural break by applying two different seasonal adjustments to this series, one before and one after the break date. The seasonal components were removed by regressing this variable on a set of seasonal dummies. For consistency we applied the same procedure to all inflation series in the euro area (and simply removed the seasonal components from the U.S. ones). We also tried not to do so (i.e. treating for seasonality only the euro area tradeable inflation series) but the results are not affected in a substantive matter.

The stochastic part of the model features 9 structural shocks and 10 measurement errors. The structural shocks are illustrated in the text. They follow an autoregressive process of order one except the two i.i.d. monetary policy shocks. All measurement errors are i.i.d.. With regard to the number of structural vs measurement errors, our choice has been to use as many structural shocks as we deemed necessary for the economic issue we wanted to study and to deal with stochastic singularity by adding measurement errors to all observed variables. This choice has the main advantage of keeping separate the economic intuition behind the model from the technical details of the estimation procedure. Moreover, the size of the variances estimated for the measurement errors provides us with an important insight about the dimensions along which the structural model is most likely ill-specified. In the results presented we have a total of 12 measurement errors (one for each observable, with the exception of the two interest rates). Given that these series are already very smooth, the estimated variances for their measurement errors were always negligeable and we decided to leave them out in order to increase the precision of the other estimates. Figure 1 gives a visual appreciation of the fit of the LCP-DC model at the posterior mean values of the parameters.

Simulating the posterior distribution of the parameters

We use a standard Metropolis-Hastings algorithm in order to obtain a sample of draws from the posterior distribution.[34] The algorithm was started from a neighborhood of the posterior mode (found by maximizing the kernel of the posterior using a numerical routine) and then instructed to move around the parameter space using a multivariate normal random walk whose covariance matrix was a scaled variant of the inverse Hessian estimated at the posterior mode. The scale parameter was set to achieve an efficient exploration of the space. This algorithm defines a Markov Chain which eventually generates draws coming from the posterior distribution. Since these draws can (and will in general) be autocorrelated, we run long chains (typically of one million draws), check for convergence of the chain to the posterior distribution (using cumulative plots statistics) and them

[33]Using a linear trend for the trade balance does not alter substantially any of the results, but does not completely remove the trend in the resulting series.

[34] See An and Schorfheide (2005) for a review of Bayesian methods for estimation of DSGE models.

kept one every 100th draws. This procedure results in a sub-sample of almost uncorrelated draws from the posterior, which can then be used to approximate all moments and quantities of interest.[35]

[35]Geweke (1999) reviews regularity conditions that guarantee the convergence to the posterior distribution of the Markov chains generated by the Metropolis-Hastings algorithm. More details on bayesian techniques and DSGE models are in Del Negro *et al.* (2004), Schorfheide (2000), DeJong *et al.* (2000). For an applicaton of maximum likelihood methods see Ireland (2004) and Kim (2000).

References

[1] An, Sungbae, and Frank Schorfheide (2005). "Bayesian Analysis of DSGE Models", University of Pennsylvania, unpublished.

[2] Adolfson, Malin, Stefan Laseen, Jesper Lindé, and Mattias Villani (2007). "Bayesian Estimation of an Open Economy DSGE Model with Incomplete Pass-Through", *Journal of International Economics*, forthcoming.

[3] Backus, David K., and Gregory W. Smith (1993). "Consumption and Real Exchange Rate in Dynamic Economies with Non Traded Goods", *Journal of International Economics*, 35, 297-316.

[4] Benigno Gianluca (2004). "Real Exchange Rate Persistence and Monetary Policy Rules", *Journal of Monetary Economics*, 51, 473-502.

[5] Benigno, Gianluca, and Christoph Thoenissen (2006). "Consumption and Real Exchange Rates with Incomplete Markets and Non-Traded Goods", CEP Discussion Papers.

[6] Benigno, Pierpaolo (2001). "Price Stability with Imperfect Financial Integration", New York University, unpublished.

[7] Bergin, Paul R. (2003). "Putting the 'New Open Economy Macroeconomics' to a Test", *Journal of International Economics*, 60, 3-34.

[8] Bergin, Paul R. (2004). "How Well Can the New Open Economy Macroeconomics Explain the Exchange Rate and the Current Account?", *Journal of International Money and Finance*.

[9] Betts, Caroline, and Michael B. Devereux (2000). "Exchange Rate Dynamics in a Model of Pricing to Market", *Journal of International Economics*, 50,1 (2000) 215-244

[10] Bils, Mark, and Peter J. Klenow (2002). "Some Evidence on the Importance of Sticky Prices", NBER Working Paper no. 9069, July.

[11] Burstein, Ariel, Martin Eichenbaum, and Sergio Rebelo (2006). "The Importance of Nontradable Goods' Prices in Cyclical Real Exchange Rate Fluctuations", *Japan and the World Economy*, 18 (3), August, 247-253.

[12] Burstein, Ariel T., Joao Neves, and Sergio Rebelo (2003). "Distribution Costs and Real Exchange Rate Dynamics During Exchange-Rate-Based Stabilizations", *Journal of Monetary Economics*, 50, 1189-1214.

[13] Campa, José M., and Linda S. Goldberg (2008). "The Insensitivity of the CPI to Exchange Rates: Distribution Margins, Imported Inputs, and Trade Exposure", unpublished, New York: Federal Reserve Bank of New York.

[14] Chari, V.V., Patrick Kehoe, and Ellen McGrattan (2002). "Can Sticky Price Models Generate Volatile and Persistent Real Exchange Rate", *Review of Economic Studies*, 69, 533-563.

[15] Choudhri, Ehsan, Hamid Faruqee, and Dalia S. Hakura (2005). "Explaining the exchange rate pass-through in different prices", *Journal of International Economics*, 65, 349-374.

[16] Corsetti, Giancarlo, Luca Dedola, and Sylvain Leduc (2005). "DSGE models with high exchange rate volatility and low pass-through", International Finance Discussion Papers of the Federal Reserve Board, no. 845, November.

[17] Corsetti, Giancarlo, Luca Dedola, and Sylvain Leduc (2006). "International Risk-Sharing and The Transmission of Productivity Shocks", Manuscript, European University Institute.

[18] Dedola, Luca, and Sylvain Leduc (2001). "Why Is the Business-Cycle Behavior of Fundamentals Alike across Exchange-Rate Regimes?", *International Journal of Finance & Economics*, 6(4), 401-19.

[19] DeJong, David N., Beth F. Ingram, and Charles H. Whiteman (2000). "A Bayesian Approach to Dynamic Macroeconomics", *Journal of Econometrics* 98, 203-223.

[20] Del Negro, Marco, Frank Schorfheide, Frank Smets, and Raf Wouters (2004). "On the Fit and Forecasting Performance of New-Keynesian Models", Federal Reserve Bank of Atlanta, manuscript.

[21] Devereux, Michael B., and Charles Engel (2002). "Exchange Rate Pass-Though, Exchange Rate Volatility and Exchange Rate Disconnect", *Journal of Monetary Economics*, 49, 913-940.

[22] Devereux, Michael B., and Charles Engel (2003). "Monetary Policy in the Open Economy Revisited: Price Setting and Exchange Rate Flexibility" *Review of Economic Studies,* 70, 765-783.

[23] De Walque, Gregory, and Raf Wouters (2004), "An Open Economy DSGE Model Linking the Euro Area and the US Economy", October, mimeo.

[24] Duarte, Margarida (2003). "Why don't macroeconomic quantities respond to exchange rate variability", *Journal of Monetary Economics,* 50, 889-913.

[25] Duarte, Margarida, and Alan Stockman (2005). "Rational Speculation and Exchange Rates", *Journal of Monetary Economics,* 52, 3-29.

[26] Dootsey, Michael and Margarida Duarte (2007). "Nontraded Goods, Market Segmentation, and Exchange Rates", mimeo.

[27] Eichenbaum, Martin, and Jonas D.M. Fisher (2005). "Evaluating Calvo-Style Sticky Price Models", mimeo, March.

[28] Fabiani Silvia, Martine Druant, Ignacio Hernando, Claudia Kwapil, Bettina Landau, Claire Loupias, Fernando Martins, Thomas Y. Mathä, Roberto Sabbatini, Harald Stahl and Ad C. J. Stokman (2005). "The Pricing Behavior of Firms in the Euro Area. Some New Evidence", ECB Working Paper, 535, October.

[29] Geweke, John (1999). "Using Simulation Methods for Bayesian Econometric Models: Inference, Development and Communication", *Econometric Reviews*, 18, 1-126.

[30] Hau, Harald (2000). "Exchange Rate Determination under Factor Price Rigidities", *Journal of International Economics*, 50(2), 421-447.

[31] Ireland, Peter (2004). "A Method for Taking Models to the Data", *Journal of Economic Dynamics and Control*, 28(6), 1205-1226.

[32] Jeanne, Olivier, and Andrew Rose (2002). "Noise Trading and Exchange Rate Regimes", *Quarterly Journal of Economics*, May, 117(2), 537-569.

[33] Justiniano, Alejandro and Bruce Preston (2006). "Monetary Policy and Uncertainty in an Empirical Small Open Economy Model ", Manuscript, Columbia University.

[34] Kim, Jinill (2000). "Constructing and estimating a realistic optimizing model of monetary policy", *Journal of Monetary Economics*, 45, 329-359.

[35] Kollmann, Robert (2001). "The exchange rate in a dynamic-optmizing business cycle model with nominal rigidities: a quantitative investigation", *Journal of International Economics*, 55, 243-262.

[36] Kollmann, Robert (2005). "Macroeconomic effects of nominal exchange rate regimes: new insights into the role of price dynamics", *Journal of International Money and Finance*, 24, 275-292.

[37] Lubik, Thomas, and Frank Schorfheide (2005). "A Bayesian Look at New Open Economy Macroeconomics", NBER Macroeconomics Annual.

[38] Mendoza, Enrique (1991). "Real Business Cycles in a Small Open Economy", *American Economic Review*, 81(4), 797-818.

[39] Obstfeld, Maurice and Kenneth Rogoff (1995). "Exchange Rate Dynamics Redux," Journal of Political Economy 103 (June): 624-60.

[40] Obstfeld, Maurice, and Kenneth Rogoff (2000). "New directions for stochastic open economy models", Journal of International Economics, 50, 117–153.

[41] Ortega, Eva, and Nooman Rebei (2006). "The Welfare Implications of Inflation versus Price-Level Targeting in a Two-Sector, Small Open Economy", Bank of Canada 2006-12.

[42] Rabanal, Pau and Vicente Tuesta (2006). "Euro-Dollar Real Exchange Rate Dynamics in an Estimated Two-Country Model: What Is Important and What Is Not", International Monetary Fund Working Paper No. 06/177, July.

[43] Rabanal, Pau and Vicente Tuesta (2007). "Non Tradable Goods and the Real Exchange Rate", La Caixa Working Paper No. 03/2007.

[44] Rotemberg, Julio (1982). "Monopolistic Price Adjustment and Aggregate Output", *Review of Economic Studies*, 49, 517-31.

[45] Schmitt-Grohé, Stephanie, and Martin Uribe (2003). "Closing small open economy models", *Journal of International Economics*, 61, 163-185.

[46] Schorfheide, Frank (2000). "Loss Function-Based Evaluation of DSGE Models", *Journal of Applied Econometrics*, 15, 645-670.

[47] Smets, Frank and Raf Wouters (2003). "An Estimated Stochastic Dynamic General Equilibrium Model for the euro area", *Journal of the European Economic Association*, 1, 1123-1175.

[48] Smets, Frank and Raf Wouters (2005). "Comparing Shocks and Frictions in U.S. and euro area Business Cycles: A Bayesian DSGE Approach", *Journal of Applied Econometrics*, 20, 161-183.

[49] Stockman, Alan C., and Linda Tesar (1995). "Tastes and Technology in a Two-Country Model of the Business Cycle: Explaining International Comovements", *American Economic Review*, 83, 473-86.

[50] Turnovsky, S.J. (1985). "Domestic and Foreign Disturbances in an Optimizing Model of Exchange-Rate Determination", *Journal of International Money and Finance*, 4(1), 151-171.

[51] Warnock, Francis (2003). "Exchange rate dynamics and the welfare effects of monetary policy in a two-country model with home-product bias", *Journal of International Money and Finance*, 22, 343-363.

[52] Woodford, Michael (1998). "Doing without Money: Controlling Inflation in a Post-monetary World", *Review of Economic Dynamics*, 1, 173-219.

Table 1. Estimates: prior and posterior statistics

	posterior					prior	
parameter	2.5	50	97.5	mean	st.dev	mean	st. dev.
ϕ_b	0.010	0.014	0.020	0.014	0.002	0.010	0.005
ϕ	1.336	1.471	1.616	1.473	0.072	1.140	0.10
ρ	0.597	0.733	0.893	0.736	0.076	0.740	0.10
σ	1.856	2.113	2.406	2.118	0.140	2.000	0.20
a_H	0.897	0.918	0.936	0.918	0.063	0.950	0.10
a_T	0.400	0.461	0.525	0.462	0.010	0.450	0.10
η	0.892	1.009	1.137	1.010	0.032	1.200	0.10
ρ_R	0.787	0.822	0.854	0.821	0.017	0.800	0.10
ρ_π	1.505	1.659	1.818	1.660	0.080	1.500	0.10
ρ_y	0.209	0.263	0.319	0.263	0.028	0.100	0.10
ρ_s	-0.052	-0.034	-0.015	-0.034	0.009	0.000	0.10
ρ_R^*	0.864	0.890	0.913	0.890	0.013	0.800	0.10
ρ_π^*	1.371	1.515	1.666	1.516	0.076	1.500	0.10
ρ_y^*	0.120	0.206	0.301	0.207	0.046	0.100	0.10
ρ_s^*	-0.071	-0.040	-0.009	-0.040	0.016	0.000	0.10
κ_H	24.209	43.721	77.496	45.527	13.711	5.600	10.00
κ_F	1.118	5.727	24.012	7.453	6.247	5.600	10.00
κ_N	74.398	130.845	217.798	134.745	36.900	5.600	10.00
κ_H^*	0.337	5.225	50.003	10.195	13.733	5.600	10.00
κ_F^*	1.827	4.909	12.979	5.547	2.940	5.600	10.00
κ_N^*	33.899	70.012	133.469	73.609	25.624	5.600	10.00
κ_W	160.236	249.736	373.026	254.206	54.507	63.000	40.00
κ_W^*	201.123	294.269	420.262	298.580	56.176	63.000	40.00
ρ_ξ	0.880	0.908	0.930	0.907	0.013	0.900	0.05
ρ_ξ^*	0.860	0.890	0.915	0.890	0.014	0.900	0.05
ρ_μ	0.889	0.923	0.949	0.922	0.015	0.900	0.05
ρ_H	0.847	0.891	0.926	0.890	0.020	0.900	0.05
ρ_N	0.898	0.934	0.960	0.933	0.016	0.900	0.05
ρ_F^*	0.887	0.945	0.976	0.941	0.023	0.900	0.05
ρ_N^*	0.918	0.955	0.978	0.953	0.016	0.900	0.05
σ_ξ	0.022	0.026	0.031	0.026	0.002	0.001	0.01
σ_ξ^*	0.016	0.019	0.023	0.019	0.002	0.001	0.01
σ_μ	0.004	0.005	0.007	0.005	0.001	0.001	0.01
σ_R	0.001	0.001	0.001	0.001	0.000	0.001	0.01
σ_R^*	0.001	0.001	0.001	0.001	0.000	0.001	0.01
σ_H	0.015	0.022	0.032	0.022	0.004	0.001	0.01
σ_N	0.003	0.005	0.007	0.005	0.001	0.001	0.01
σ_F^*	0.009	0.012	0.017	0.012	0.002	0.001	0.01
σ_N^*	0.002	0.003	0.005	0.003	0.001	0.001	0.01

Notes: Posterior statistics are based on 1,000,000 draws.

Table 2. Estimates: nominal rigidities

Nominal rigidities	Cost	Probability	Frequency
euro area			
import (border)	5.73	0.27	1.37
domestic tradeable (wholesale)	43.72	0.61	2.56
nontradeable	130.84	0.83	5.88
wages	249.73	0.90	10.00
U. S.			
import (border)	5.23	0.26	1.35
domestic tradeable (wholesale)	4.91	0.25	1.33
nontradeable	70.01	0.77	4.35
wages	294.27	0.90	10.00

Notes: The column denoted with cost reports the parameter measuring the cost for adjusting prices (posterior median values). The column denoted with probability reports the implicit Calvo probability for a firm of not being able to reset prices optimally. The column denoted with frequency reports the average duration of prices, computed on the basis of the Calvo probability.

Table 3. Goodness of fit: selected second moments

		volatility				*persistence*			
		Data	2.5	50	97.5	Data	2.5	50	97.5
real exchange rate	RS	8.40	4.84	6.43	8.58	0.81	0.46	0.66	0.79
euro area CPI inflation	π	0.21	0.15	0.20	0.26	0.20	0.33	0.54	0.70
U.S. CPI inflation	π^*	0.31	0.17	0.21	0.27	0.17	0.12	0.35	0.55
EA wholesale domestic tradable infl.	$\bar{\pi}_H$	0.61	0.44	0.56	0.71	0.66	0.29	0.50	0.66
U.S. wholesale domestic tradable infl.	$\bar{\pi}_F^*$	0.68	0.57	0.70	0.85	0.17	0.00	0.24	0.45
EA nontradable inflation	π_N	0.21	0.10	0.15	0.20	0.30	0.45	0.65	0.78
U.S. nontradable inflation	π_N^*	0.17	0.09	0.13	0.18	0.09	0.42	0.62	0.76
EA nominal interest rate	R	0.19	0.13	0.19	0.27	0.87	0.64	0.79	0.88
U.S. nominal interest rate	R^*	0.25	0.11	0.14	0.20	0.88	0.51	0.69	0.81
EA consumption	C	0.80	0.56	0.73	0.96	0.77	0.41	0.60	0.74
U.S. consumption	C^*	0.75	0.56	0.74	0.97	0.80	0.41	0.60	0.75

Notes: Results are on 500 draws from the posterior distribution and 100 time series of the variables.

Table 4. Goodness of fit: cross-correlations

	Data	2.5	50	97.5
RS, π	0.29	-0.29	0.05	0.38
RS, $\pi^\star$	-0.03	-0.41	-0.13	0.17
RS, $\bar{\pi}_H$	0.21	-0.36	-0.05	0.26
RS, $\bar{\pi}_F^\star$	-0.13	-0.25	0.01	0.26
RS, π_N	0.00	-0.47	-0.13	0.25
RS, $\pi_N^\star$	-0.02	-0.33	0.02	0.37
RS, R	0.21	-0.55	-0.19	0.24
RS, $R^\star$	0.21	-0.21	0.20	0.55
RS, C	-0.29	-0.55	-0.26	0.09
RS, $C^\star$	0.25	-0.23	0.13	0.46
RS, $C - C^\star$	-0.37	-0.56	-0.27	0.09
C, $C^\star$	-0.09	-0.38	-0.05	0.29
TB, C	-0.34	-0.65	-0.41	-0.10

Notes: Results are on 500 draws from the posterior distribution and 100 time series of the variables.

Table 5. Real exchange rate fluctuations

(Percentage of variance of the real exchange rate)

component	2.5	50	97.5
	.	.	.
$\sigma^2(IRS)$	0.1	0.19	0.34
$\sigma^2(HB)$	2.3	5.93	11.86
$\sigma^2(IPD)$	41.6	58.75	76.54
$cov(IPD, HB)$	-0.1	0.63	1.86
$cov(IRS, IPD)$	1.3	3.34	5.66
$cov(HB, IPD)$	18.2	31.14	41.44

Notes: Results are on 500 draws from the posterior distribution and 100 time series of the variables. 2.5, 50, 97.5 are percentiles of the draws. IRS is for internal real exchange rate (it includes both euro area and US terms), HB for home bias, IPD is for international price discrimination (it includes both euro area and U.S. terms).

Table 6. Sensitivity analysis: comparison of modes

parameter	LCP-DC	no NT	no HB	PCP	LCP	no UIRP
ϕ_b	0.014	0.010	0.013	0 014	0.013	0.008
ϕ	1.474	1.160	0.998	1 173	1.184	1.368
ρ	0.734	-	0.574	0 745	0.746	0.764
σ	2.117	2.120	1.985	2 096	2.095	2.143
η	1.008	-	-	-	-	1.060
a_H	0.917	0.990	0.5	0 970	0.968	0.871
a_T	0.462	-	0.040	0 262	0.264	0.494
ρ_R	0.821	0.830	0.770	0 823	0.825	0.828
ρ_π	1.657	2.030	1.677	1 672	1.672	1.666
ρ_y	0.262	0.210	0.231	0 260	0.262	0.257
ρ_s	-0.034	-0.030	-0.032	-0 035	-0.028	-0.055
ρ_R^*	0.889	0.890	0.876	0 899	0.891	0.898
ρ_π^*	1.513	1.570	1.534	1 508	1.503	1.539
ρ_y^*	0.203	0.200	0.184	0 143	0.206	0.221
ρ_s^*	-0.041	-0.030	-0.040	-0 040	-0.031	0.0
κ_H	45.071	61.910	86.323	35 564	39.647	35.372
κ_F	6.003	6.920	2.578	-	11.368	0.769
κ_N	131.794	-	161.421	118 951	119.300	124.388
κ_H^*	5.144	8.630	0.519	-	11.326	1.382
κ_F^*	4.973	4.210	6.402	3.746	3.932	5.189
κ_N^*	71.690	-	78.991	73 063	74.695	74.739
κ_W	252.705	169.840	167.896	245 236	246.065	226.283
κ_W^*	291.599	278.040	279.910	295 232	295.940	306.976
ρ_ξ^*	0.907	0.910	0.885	0 908	0.909	0.903
ρ_ξ	0.890	0.900	0.895	0 893	0.891	0.907
ρ_u	0.920	0.920	0.918	0 922	0.923	-
ρ_H	0.888	0.930	0.926	0 893	0.886	0.903
ρ_N	0.933	-	0.933	0 937	0.938	0.933
ρ_F^*	0.943	0.940	0.927	0 952	0.950	0.940
ρ_N^*	0.954	-	0.927	0 947	0.946	-
σ_ξ	0.026	0.030	0.023	0 026	0.026	0.030
σ_ξ^*	0.019	0.020	0.018	0 020	0.019	0.020
σ_u	0.005	0.000	0.005	0 005	0.005	0.000
σ_R^*	0.001	0.000	0.001	0 001	0.001	0.000
σ_R^*	0.001	0.000	0.001	0 001	0.001	0.000
σ_H^*	0.022	0.010	0.028	0 018	0.020	0.010
σ_N^*	0.005	-	0.004	0 005	0.005	-
σ_F^*	0.012	0.000	0.013	0 010	0.010	0.000
σ_N^*	0.003	-	0.004	0 003	0.003	-
ML	4607.000	-	4548.000	4621 000	4625.000	4503.000
Concentrated ML	3807.000	3811.000	-	-	-	-

Notes: Each column report the posterior mode. ML denotes the marginal likelihood.

Table 7. Sensitivity analysis with respect to selected features
Volatility

	Data	LCP-DC	LCP	PCP	no-HB	no-NT
RS	8.40	6.43	4.80	4.61	4.48	3.74
π	0.21	0.20	0.42	0.44	0.33	0.90
π^*	0.31	0.21	0.44	0.47	0.35	0.95
$\bar{\pi}_H$	0.61	0.56	0.83	0.83	0.57	0.93
$\bar{\pi}_F^*$	0.68	0.70	0.89	0.91	0.71	0.96
π_N	0.21	0.15	0.16	0.16	0.15	0.24
π_N^*	0.17	0.13	0.14	0.15	0.13	0.20
R	0.19	0.19	0.24	0.25	0.19	0.44
R^*	0.25	0.14	0.16	0.17	0.15	0.26
C	0.80	0.73	0.85	0.86	0.92	1.16
C^*	0.75	0.74	0.80	0.73	0.86	0.99

Notes: median values. Results are on 500 draws from the posterior distribution and 100 time series of the variables.

Table 8. Sensitivity analysis with respect to selected features
Persistence

	Data	LCP-DC	LCP	PCP	no-HB	no-NT
RS	0.81	0.66	0.65	0.66	0.63	0.64
π	0.20	0.54	0.43	0.38	0.30	0.42
π^*	0.17	0.35	0.18	0.15	0.27	0.17
$\bar{\pi}_H$	0.66	0.50	0.43	0.43	0.50	0.44
$\bar{\pi}_F^*$	0.17	0.24	0.16	0.16	0.24	0.17
π_N	0.30	0.65	0.67	0.67	0.65	0.70
π_N^*	0.09	0.62	0.64	0.65	0.62	0.68
R	0.87	0.79	0.80	0.80	0.78	0.81
R^*	0.88	0.69	0.71	0.72	0.71	0.74
C	0.77	0.60	0.63	0.63	0.64	0.70
C^*	0.80	0.60	0.62	0.61	0.64	0.66

Notes: median values. Results are on 500 draws from the posterior distribution and 100 time series of the variables.

Table 9. Sensitivity analysis with respect to selected features
Cross-correlations

	Data	LCP-DC	LCP	PCP	no-HB	no-NT
RS, π	0.29	0.05	0.11	0.12	0.49	0.07
RS, $\pi^{\star}$	-0.03	-0.13	-0.18	-0.19	-0.50	-0.17
RS, $\bar{\pi}_H$	0.21	-0.05	-0.02	-0.03	-0.01	-0.04
RS, $\bar{\pi}_F^{\star}$	-0.13	0.01	-0.04	-0.04	-0.03	-0.07
RS, π_N	0.00	-0.13	-0.01	-0.01	0.07	0.16
RS, $\pi_N^{\star}$	-0.02	0.02	-0.10	-0.11	-0.22	-0.25
RS, R	0.21	-0.19	0.05	0.10	0.39	0.18
RS, $R^{\star}$	0.21	0.20	-0.01	-0.10	-0.24	-0.20
RS, C	-0.29	-0.26	-0.41	-0.42	-0.56	-0.30
RS, $C^{\star}$	0.25	0.13	0.27	0.41	0.39	0.29
RS, $C/C^{\star}$	-0.37	-0.27	-0.46	-0.54	-0.58	-0.41
C, $C^{\star}$	-0.09	-0.05	-0.11	-0.17	-0.33	-0.06
TB, C	-0.34	-0.41	-0.44	-0.46	-0.65	-0.38

Notes: median values. Results are on 500 draws from the posterior distribution and 100 time series of the variables.

Table 10. Sensitivity analysis with respect to shocks
Volatility

	Data	UIRP	UIRP+tech	UIRP+tech+mon	All
RS	8.40	6.22	6.24	6.29	6.43
π	0.21	0.05	0.19	0.19	0.20
π^*	0.31	0.05	0.20	0.20	0.21
$\bar{\pi}_H$	0.61	0.00	0.55	0.55	0.56
$\bar{\pi}_F^*$	0.68	0.00	0.69	0.69	0.70
π_N	0.21	0.00	0.12	0.12	0.15
π_N^*	0.17	0.00	0.11	0.11	0.13
R	0.19	0.02	0.09	0.13	0.19
R^*	0.25	0.02	0.06	0.13	0.14
C	0.80	0.09	0.2	0.27	0.73
C^*	0.75	0.08	0.15	0.36	0.74

Notes: median values. Results are on 500 draws from the posterior distribution and 100 time series of the variables.

Table 11. Sensitivity analysis with respect to shocks
Persistence

	Data	UIRP	UIRP+tech	UIRP+tech+mon	All
RS	0.81	0.65	0.66	0.65	0.66
π	0.20	0.23	0.31	0.51	0.54
π^*	0.17	0.23	0.49	0.32	0.35
$\bar{\pi}_H$	0.66	0.79	0.23	0.50	0.50
$\bar{\pi}_F^*$	0.17	0.80	0.62	0.23	0.24
π_N	0.30	0.86	0.59	0.62	0.65
π_N^*	0.09	0.83	0.84	0.60	0.62
R	0.87	0.44	0.8	0.69	0.79
R^*	0.88	0.53	0.84	0.63	0.69
C	0.77	0.81	0.83	0.71	0.60
C^*	0.80	0.83	0.55	0.64	0.60

Notes: median values. Results are on 500 draws from the posterior distribution and 100 time series of the variables.

Table 12. Sensitivity analysis with respect to shocks
Cross-correlations

	Data	UIRP	UIRP+tech	UIRP+tech+mon	All
RS, π	0.29	0.54	0.13	0.13	0.05
RS, $\pi^\star$	-0.03	-0.55	-0.15	-0.17	-0.13
RS, $\bar{\pi}_H$	0.21	-0.96	-0.02	-0.02	-0.05
RS, $\bar{\pi}_F^\star$	-0.13	0.92	0.00	-0.01	0.01
RS, π_N	0.00	-0.67	-0.03	-0.03	-0.13
RS, $\pi_N^\star$	-0.02	0.10	0.00	-0.03	0.02
RS, R	0.21	-0.55	-0.12	-0.12	-0.19
RS, $R^\star$	0.21	0.76	0.20	0.18	0.20
RS, C	-0.29	-0.94	-0.39	-0.25	-0.26
RS, $C^\star$	0.25	0.91	0.42	0.08	0.13
RS, $C/C^\star$	-0.37	-0.93	-0.57	-0.22	-0.27
C, $C^\star$	-0.09	-0.99	0.04	0.02	-0.05
TB, C	-0.34	-0.87	-0.42	-0.30	-0.41

Notes: median values. Results are on 500 draws from the posterior distribution and 100 time series of the variables.

Table 13. Asymptotic forecast error variance decomposition

Variable	z_H	z_F^*	z_N	z_N^*	z_R	z_R^*	z_ξ	z_ξ^*	z_μ	ME	Total
euro-area											
C	4.6	0.2	7.5	0.0	3.7	0.0	79.6	0.2	4.2	0.0	100
π	32.4	0.1	24.8	0.0	0.2	0.0	20.0	0.1	3.3	19.0	100
$\bar{\pi}_H$	89.7	0.0	3.8	0.0	0.1	0.0	6.1	0.0	0.3	0.0	100
π_N	12.7	0.0	34.0	0.0	0.2	0.0	23.1	0.1	1.5	28.4	100
π_W	5.3	0.0	6.2	0.0	0.2	0.0	12.9	0.0	0.6	74.7	100
TB	0.0	0.0	0.0	0.0	0.0	0.0	2.6	1.2	20.4	75.7	100
R	9.7	0.0	11.1	0.0	7	0.0	70.9	0.1	1.2	0	100
RS	0.1	0.1	0.3	0.2	0.1	0.4	6.8	2.5	89.5	0	100
U.S.											
C	0.3	5.3	0.0	6.1	0.0	16.1	0.5	67.8	3.9	0.0	100
π^*	0.3	38.3	0.0	18.4	0.0	2.5	0.2	8.5	3.2	28.5	100
$\bar{\pi}_F^*$	0.0	94.5	0.0	2.1	0.0	0.6	0.0	2.4	0.3	0.0	100
π_N^*	0.0	18.9	0.0	35.3	0.0	3.5	0.3	13.4	2.1	26.6	100
π_W^*	0.0	9.1	0.0	8.1	0.0	2.7	0.1	10.6	1.0	68.4	100
R^*	0.1	13.2	0.0	12.9	0.0	28.1	0.3	43.1	2.4	0.0	100

Notes: Each figure in the table is computed using the median of the marginal posterior distribution of the parameters. ME is for measurement errors.

Figure 1. Data and fitted variables

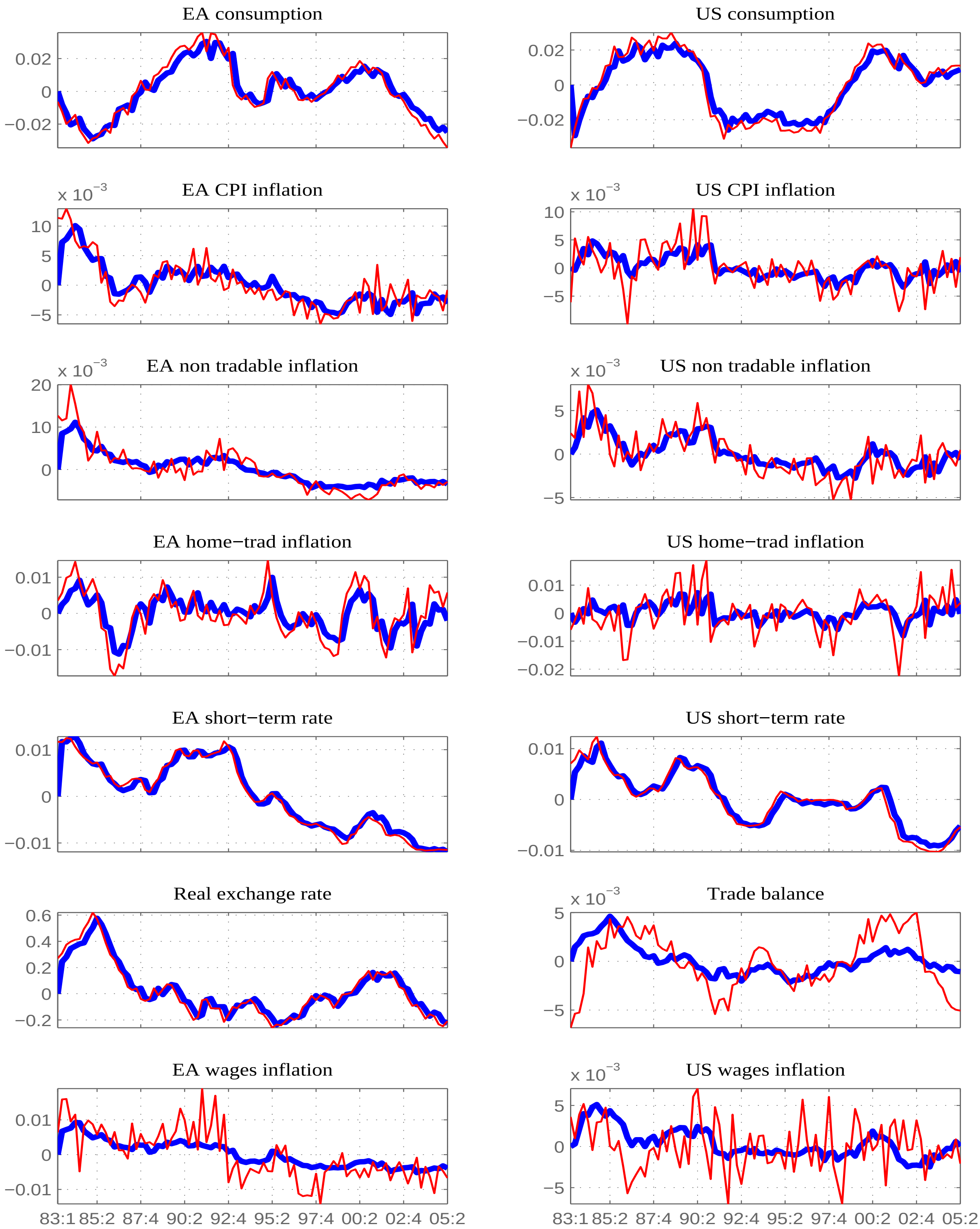


Figure 2. Decomposition of the euro-dollar real exchange rate

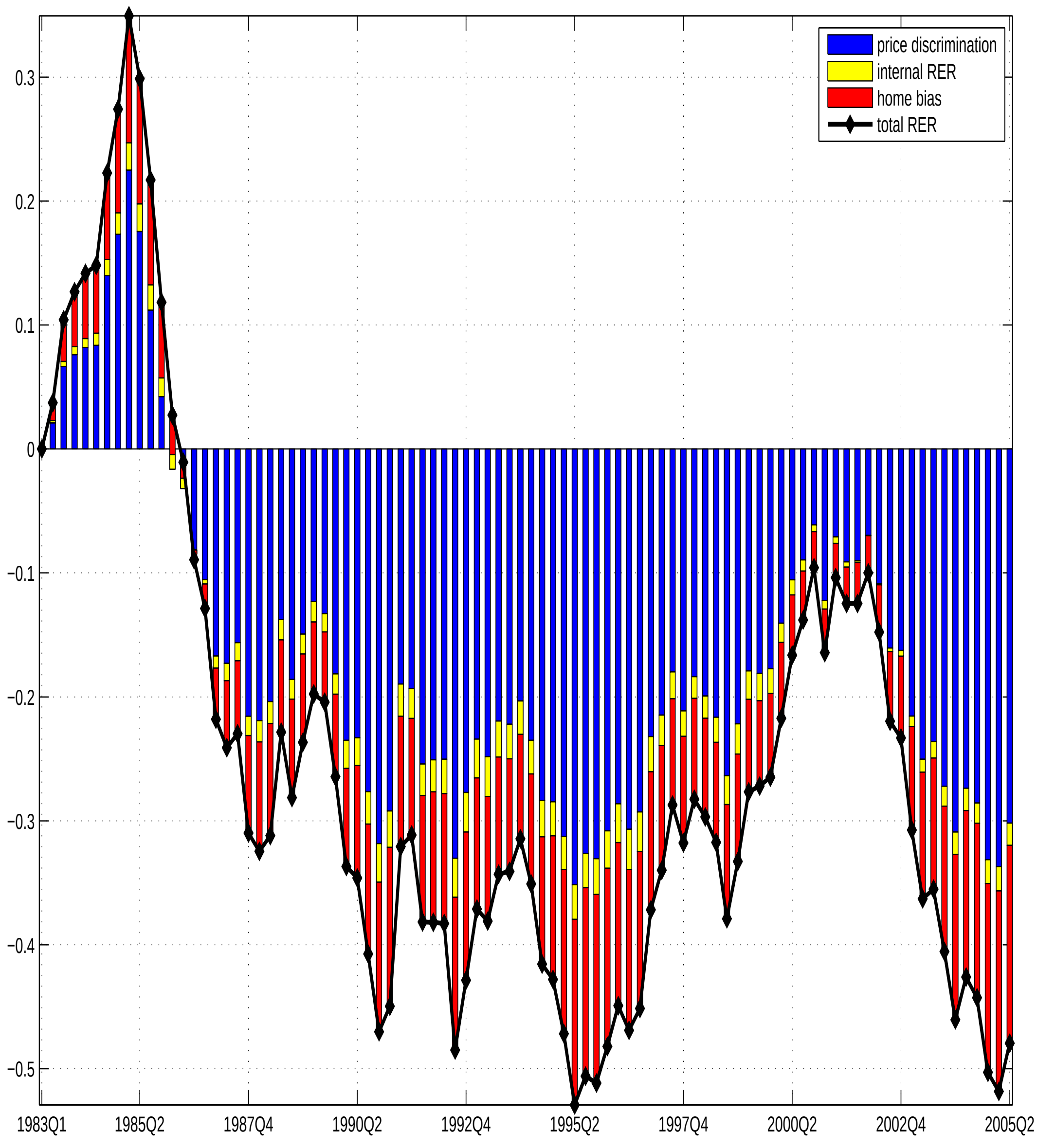


Figure 3. Impulse response analysis: UIRP shock

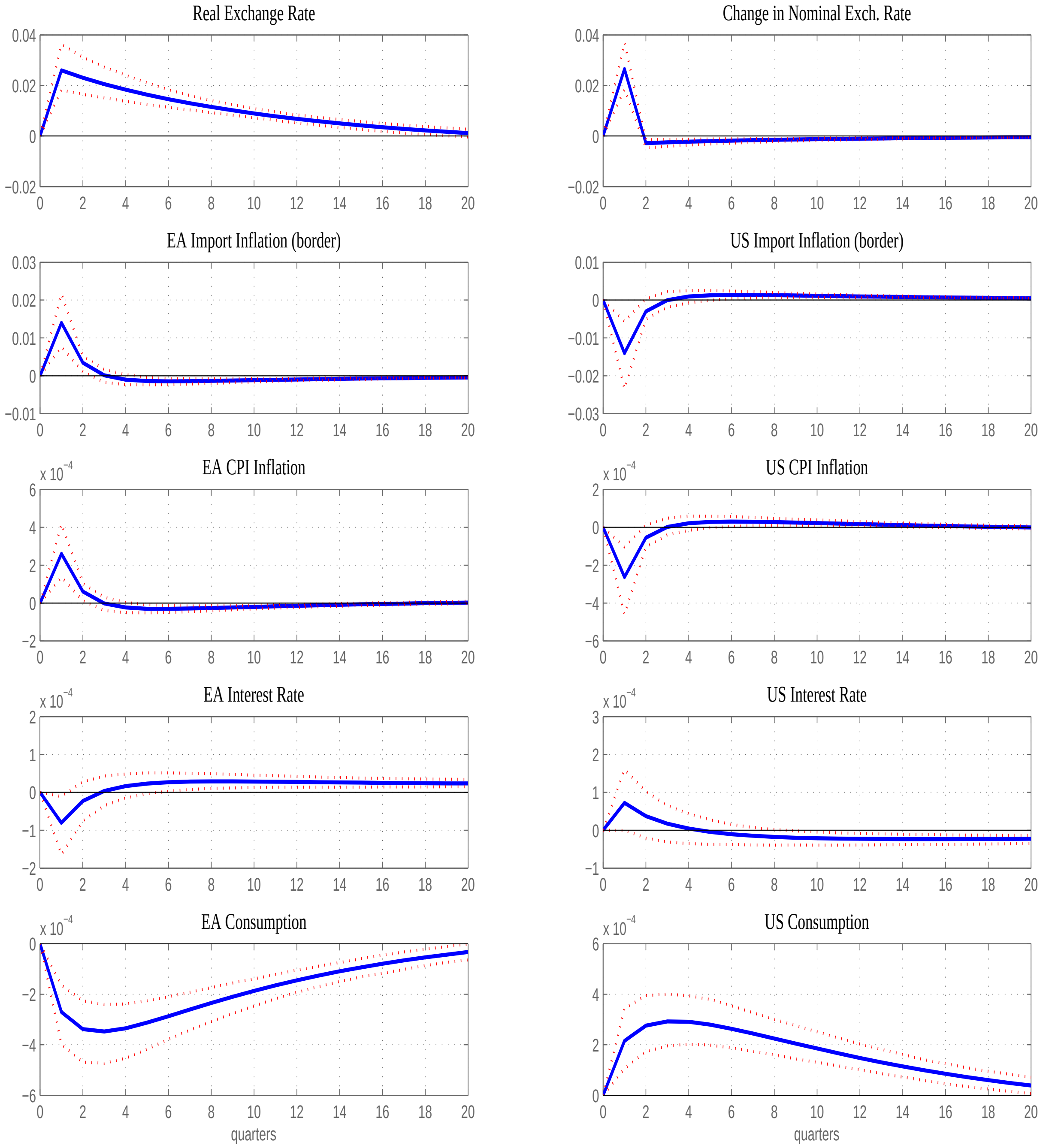


Figure 4. Impulse response analysis: exchange rate pass-through and terms of trade

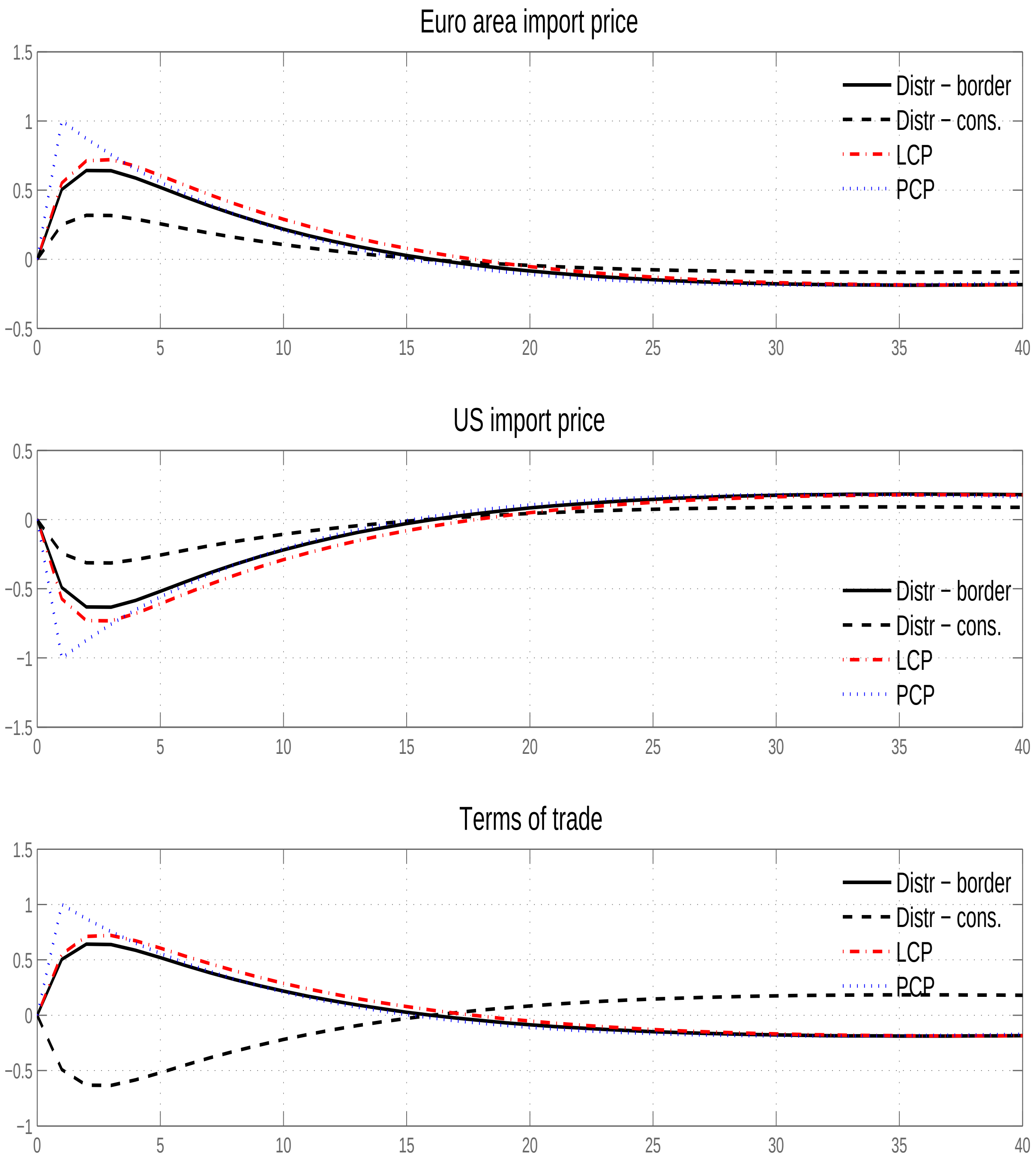


Figure 5. Impulse response analysis: euro area preference shock

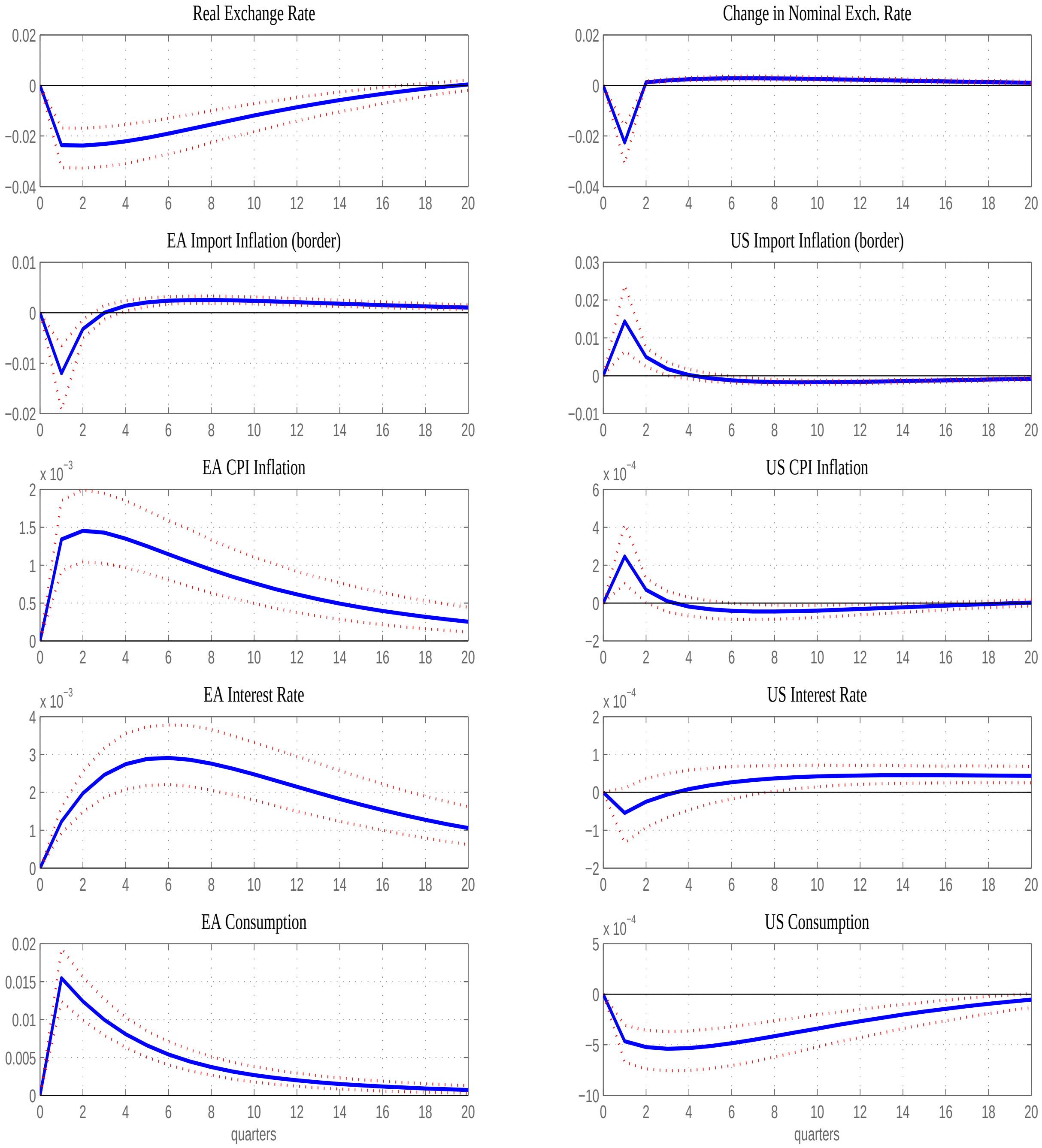


Figure 6. Impulse response analysis: euro area tradable technology shock

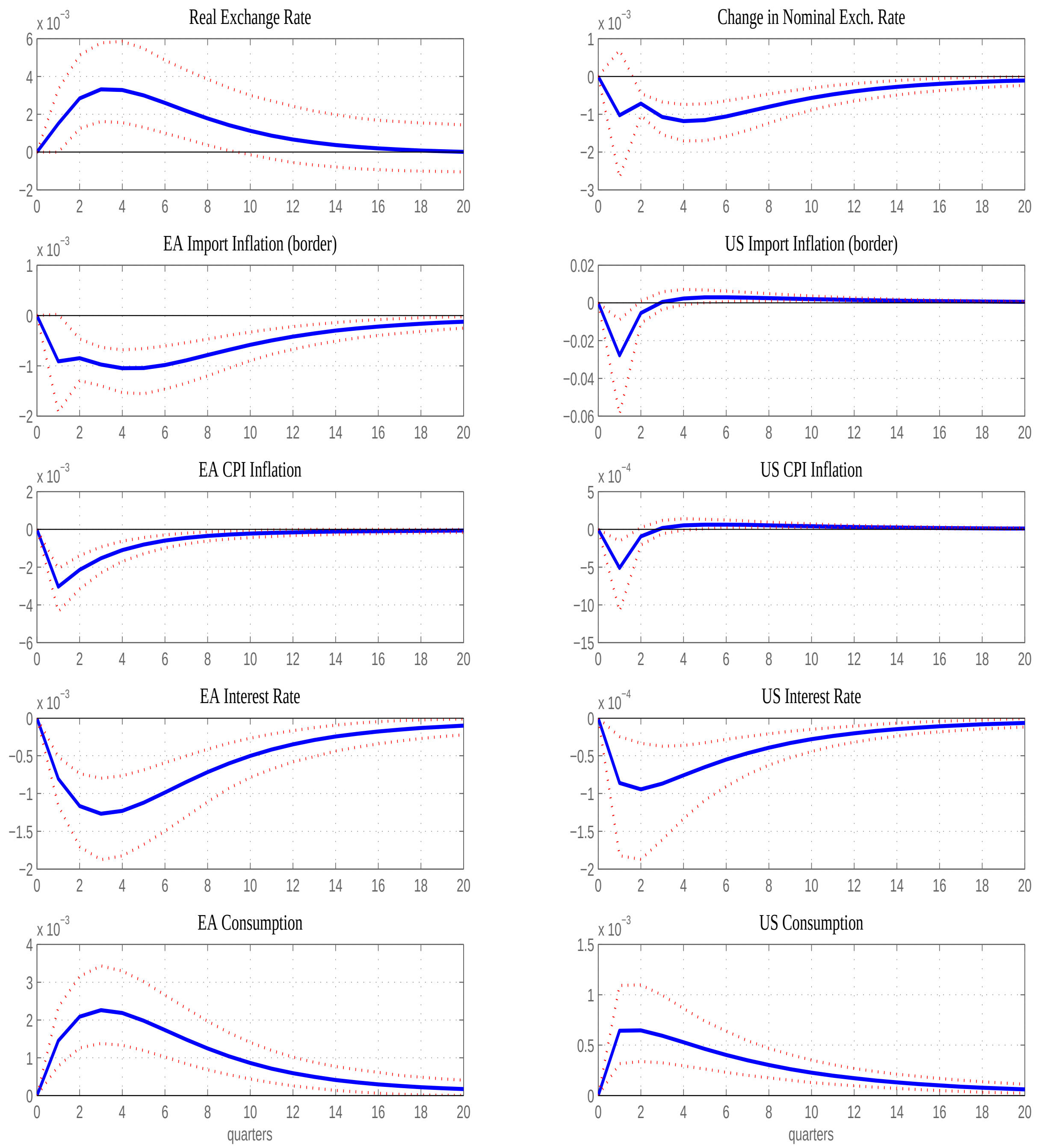
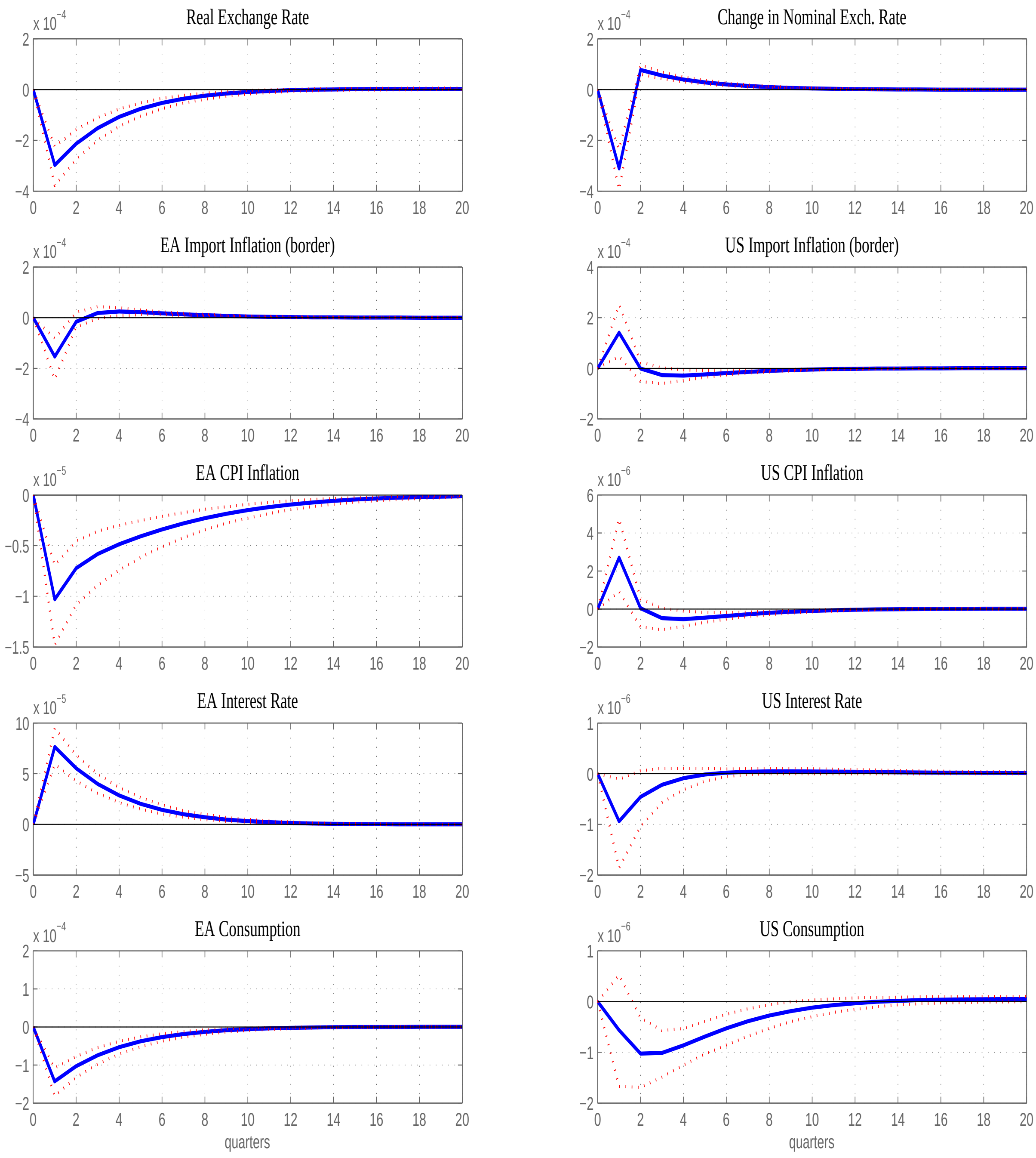


Figure 7. Impulse response analysis: euro area monetary policy shock



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G. DE BLASIO, *Does trade credit substitute bank credit? Evidence from firm-level data.* Economic notes, Vol. 34, 1, pp. 85-112, **TD No. 498 (June 2004).**

A. DI CESARE, *Estimating expectations of shocks using option prices,* The ICFAI Journal of Derivatives Markets, Vol. 2, 1, pp. 42-53, **TD No. 506 (July 2004).**

M. BENVENUTI and M. GALLO, *Il ricorso al "factoring" da parte delle imprese italiane,* in L. Cannari, S. Chiri e M. Omiccioli (eds.), *Imprese o intermediari? Aspetti finanziari e commerciali del credito tra imprese in Italia*, Bologna, Il Mulino, **TD No. 518 (October 2004)**.

L. CASOLARO and L. GAMBACORTA, *Redditività bancaria e ciclo economico,* Bancaria, Vol. 61, 3, pp. 19-27, **TD No. 519 (October 2004)**.

F. PANETTA, F. SCHIVARDI and M. SHUM, *Do mergers improve information? Evidence from the loan market*, CEPR Discussion Paper, 4961, **TD No. 521 (October 2004)**.

P. DEL GIOVANE and R. SABBATINI, *La divergenza tra inflazione rilevata e percepita in Italia,* in P. Del Giovane, F. Lippi e R. Sabbatini (eds.), *L'euro e l'inflazione: percezioni, fatti e analisi,* Bologna, Il Mulino, **TD No. 532 (December 2004).**

R. TORRINI, *Quota dei profitti e redditività del capitale in Italia: un tentativo di interpretazione*, Politica economica, Vol. 21, 1, pp. 7-41, **TD No. 551 (June 2005)**.

M. OMICCIOLI, *Il credito commerciale come "collateral"*, in L. Cannari, S. Chiri, M. Omiccioli (eds.), Imprese o intermediari? Aspetti finanziari e commerciali del credito tra imprese in Italia, Bologna, il Mulino, **TD No. 553 (June 2005)**.

L. CASOLARO, L. GAMBACORTA and L. GUISO, *Regulation, formal and informal enforcement and the development of the household loan market. Lessons from Italy*, in Bertola G., Grant C. and Disney R. (eds.) The Economics of Consumer Credit: European Experience and Lessons from the US, Boston, MIT Press, **TD No. 560 (September 2005)**.

S. DI ADDARIO and E. PATACCHINI, *Lavorare in una grande città paga, ma poco*, in Brucchi Luchino (ed.), *Per un'analisi critica del mercato del lavoro*, Bologna , Il Mulino, **TD No. 570 (January 2006)**.

P. ANGELINI and F. LIPPI, *Did inflation really soar after the euro changeover? Indirect evidence from ATM withdrawals,* CEPR Discussion Paper, 4950, **TD No. 581 (March 2006)**.

S. FEDERICO, *Internazionalizzazione produttiva, distretti industriali e investimenti diretti all'estero,* in L. F. Signorini, M. Omiccioli (eds.), *Economie locali e competizione globale: il localismo industriale italiano di fronte a nuove sfide*, Bologna, il Mulino, **TD No. 592 (October 2002).**

S. DI ADDARIO, *Job search in thick markets: Evidence from Italy*, Oxford Discussion Paper 235, Department of Economics Series, **TD No. 605 (December 2006)**.

2006

F. BUSETTI, *Tests of seasonal integration and cointegration in multivariate unobserved component models,* Journal of Applied Econometrics, Vol. 21, 4, pp. 419-438, **TD No. 476 (June 2003).**

C. BIANCOTTI, *A polarization of inequality? The distribution of national Gini coefficients 1970-1996*, Journal of Economic Inequality, Vol. 4, 1, pp. 1-32, **TD No. 487 (March 2004)**.

L. CANNARI and S. CHIRI, *La bilancia dei pagamenti di parte corrente Nord-Sud (1998-2000)*, in L. Cannari, F. Panetta (a cura di), Il sistema finanziario e il Mezzogiorno: squilibri strutturali e divari finanziari, Bari, Cacucci, **TD No. 490 (March 2004).**

M. BOFONDI and G. GOBBI, *Information barriers to entry into credit markets,* Review of Finance, Vol. 10, 1, pp. 39-67, **TD No. 509 (July 2004).**

FUCHS W. and LIPPI F., *Monetary union with voluntary participation,* Review of Economic Studies, Vol. 73, pp. 437-457 **TD No. 512 (July 2004).**

GAIOTTI E. and A. SECCHI, *Is there a cost channel of monetary transmission? An investigation into the pricing behaviour of 2000 firms*, Journal of Money, Credit and Banking, Vol. 38, 8, pp. 2013-2038 **TD No. 525 (December 2004)**.

A. BRANDOLINI, P. CIPOLLONE and E. VIVIANO, *Does the ILO definition capture all unemployment?,* Journal of the European Economic Association, Vol. 4, 1, pp. 153-179, **TD No. 529 (December 2004)**.

A. BRANDOLINI, L. CANNARI, G. D'ALESSIO and I. FAIELLA, *Household wealth distribution in Italy in the 1990s,* in E. N. Wolff (ed.) International Perspectives on Household Wealth, Cheltenham, Edward Elgar, **TD No. 530 (December 2004)**.

P. DEL GIOVANE and R. SABBATINI, *Perceived and measured inflation after the launch of the Euro: Explaining the gap in Italy*, Giornale degli economisti e annali di economia, Vol. 65, 2 , pp. 155-192, **TD No. 532 (December 2004).**

M. CARUSO, *Monetary policy impulses, local output and the transmission mechanism*, Giornale degli economisti e annali di economia, Vol. 65, 1, pp. 1-30, **TD No. 537 (December 2004).**

A. NOBILI, *Assessing the predictive power of financial spreads in the euro area: does parameters instability matter?,* Empirical Economics, Vol. 31, 1, pp. 177-195, **TD No. 544 (February 2005)**.

L. GUISO and M. PAIELLA, *The role of risk aversion in predicting individual behavior, In P. A. Chiappori e C. Gollier (eds.) Competitive Failures in Insurance Markets: Theory and Policy Implications, Monaco, CESifo*, **TD No. 546 (February 2005).**

G. M. TOMAT, *Prices product differentiation and quality measurement: A comparison between hedonic and matched model methods*, Research in Economics, Vol. 60, 1, pp. 54-68, **TD No. 547 (February 2005)**.

F. LOTTI, E. SANTARELLI and M. VIVARELLI, *Gibrat's law in a medium-technology industry: Empirical evidence for Italy*, in E. Santarelli (ed.), Entrepreneurship, Growth, and Innovation: the Dynamics of Firms and Industries, New York, Springer, **TD No. 555 (June 2005).**

F. BUSETTI, S. FABIANI and A. HARVEY, *Convergence of prices and rates of inflation*, Oxford Bulletin of Economics and Statistics, Vol. 68, 1, pp. 863-878, **TD No. 575 (February 2006).**

M. CARUSO, *Stock market fluctuations and money demand in Italy, 1913 - 2003*, Economic Notes, Vol. 35, 1, pp. 1-47, **TD No. 576 (February 2006)**.

S. IRANZO, F. SCHIVARDI and E. TOSETTI, *Skill dispersion and productivity: An analysis with matched data*, CEPR Discussion Paper, 5539, **TD No. 577 (February 2006).**

R. BRONZINI and G. DE BLASIO, *Evaluating the impact of investment incentives: The case of Italy's Law 488/92.* Journal of Urban Economics, Vol. 60, 2, pp. 327-349, **TD No. 582 (March 2006).**

R. BRONZINI and G. DE BLASIO, *Una valutazione degli incentivi pubblici agli investimenti*, Rivista Italiana degli Economisti , Vol. 11, 3, pp. 331-362, **TD No. 582 (March 2006).**

A. DI CESARE, *Do market-based indicators anticipate rating agencies? Evidence for international banks*, Economic Notes, Vol. 35, pp. 121-150, **TD No. 593 (May 2006).**

L. DEDOLA and S. NERI, *What does a technology shock do? A VAR analysis with model-based sign restrictions*, Journal of Monetary Economics, Vol. 54, 2, pp. 512-549, **TD No. 607 (December 2006)**.

R. GOLINELLI and S. MOMIGLIANO, *Real-time determinants of fiscal policies in the euro area*, Journal of Policy Modeling, Vol. 28, 9, pp. 943-964, **TD No. 609 (December 2006).**

P. ANGELINI, S. GERLACH, G. GRANDE, A. LEVY, F. PANETTA, R. PERLI,S. RAMASWAMY, M. SCATIGNA and P. YESIN, *The recent behaviour of financial market volatility*, BIS Papers, 29, **QEF No. 2 (August 2006)**.

2007

L. CASOLARO. and G. GOBBI, *Information technology and productivity changes in the banking industry*, Economic Notes, Vol. 36, 1, pp. 43-76, **TD No. 489 (March 2004)**.

M. PAIELLA, *Does wealth affect consumption? Evidence for Italy*, Journal of Macroeconomics, Vol. 29, 1, pp. 189-205, **TD No. 510 (July 2004).**

F. LIPPI. and S. NERI, *Information variables for monetary policy in a small structural model of the euro area*, Journal of Monetary Economics, Vol. 54, 4, pp. 1256-1270, **TD No. 511 (July 2004)**.

A. ANZUINI and A. LEVY, *Monetary policy shocks in the new EU members: A VAR approach*, Applied Economics, Vol. 39, 9, pp. 1147-1161, **TD No. 514 (July 2004)**.

R. BRONZINI, *FDI Inflows, agglomeration and host country firms' size: Evidence from Italy*, Regional Studies, Vol. 41, 7, pp. 963-978, **TD No. 526 (December 2004).**

L. MONTEFORTE, *Aggregation bias in macro models: Does it matter for the euro area?*, Economic Modelling, 24, pp. 236-261, **TD No. 534 (December 2004)**.

A. DALMAZZO and G. DE BLASIO, *Production and consumption externalities of human capital: An empirical study for Italy*, Journal of Population Economics, Vol. 20, 2, pp. 359-382, **TD No. 554 (June 2005).**

M. BUGAMELLI and R. TEDESCHI, *Le strategie di prezzo delle imprese esportatrici italiane,* Politica Economica, v. 3, pp. 321-350, **TD No. 563 (November 2005)**.

L. GAMBACORTA and S. IANNOTTI, *Are there asymmetries in the response of bank interest rates to monetary shocks?*, Applied Economics, v. 39, 19, pp. 2503-2517, **TD No. 566 (November 2005).**

S. DI ADDARIO and E. PATACCHINI, *Wages and the city. Evidence from Italy*, Development Studies Working Papers 231, Centro Studi Luca d'Agliano, **TD No. 570 (January 2006)**.

P. ANGELINI and F. LIPPI, *Did prices really soar after the euro cash changeover? Evidence from ATM withdrawals*, International Journal of Central Banking, Vol. 3, 4, pp. 1-22, **TD No. 581 (March 2006)**.

A. LOCARNO, *Imperfect knowledge, adaptive learning and the bias against activist monetary policies*, International Journal of Central Banking, v. 3, 3, pp. 47-85, **TD No. 590 (May 2006)**.

F. LOTTI and J. MARCUCCI, *Revisiting the empirical evidence on firms' money demand*, Journal of Economics and Business, Vol. 59, 1, pp. 51-73, **TD No. 595 (May 2006)**.

P. CIPOLLONE and A. ROSOLIA, *Social interactions in high school: Lessons from an earthquake*, American Economic Review, Vol. 97, 3, pp. 948-965, **TD No. 596 (September 2006).**

A. BRANDOLINI, *Measurement of income distribution in supranational entities: The case of the European Union*, in S. P. Jenkins e J. Micklewright (eds.), Inequality and Poverty Re-examined, Oxford, Oxford University Press, **TD No. 623 (April 2007).**

M. PAIELLA, *The foregone gains of incomplete portfolios*, Review of Financial Studies, Vol. 20, 5, pp. 1623-1646, **TD No. 625 (April 2007).**

K. BEHRENS, A. R. LAMORGESE, G.I.P. OTTAVIANO and T. TABUCHI, *Changes in transport and non transport costs: local vs. global impacts in a spatial network*, Regional Science and Urban Economics, Vol. 37, 6, pp. 625-648, **TD No. 628 (April 2007).**

G. ASCARI and T. ROPELE, *Optimal monetary policy under low trend inflation*, Journal of Monetary Economics, v. 54, 8, pp. 2568-2583, **TD No. 647 (November 2007).**

R. GIORDANO, S. MOMIGLIANO, S. NERI and R. PEROTTI, *The Effects of Fiscal Policy in Italy: Evidence from a VAR Model*, European Journal of Political Economy, Vol. 23, 3, pp. 707-733, **TD No. 656 (December 2007).**

2008

S. MOMIGLIANO, J. Henry and P. Hernández de Cos, *The impact of government budget on prices: Evidence from macroeconometric models*, Journal of Policy Modelling, v. 30, 1, pp. 123-143 **TD No. 523 (October 2004).**

P. DEL GIOVANE, S. FABIANI and R. SABATINI, *What's behind "inflation perceptions"? A survey-based analysis of Italian consumers, i*n P. Del Giovane e R. Sabbatini (eds.), *The Euro Inflation and Consumers' Perceptions. Lessons from Italy*, Berlin-Heidelberg, Springer, **TD No. 655 (January 2008).**

FORTHCOMING

S. SIVIERO and D. TERLIZZESE, *Macroeconomic forecasting: Debunking a few old wives' tales*, Journal of Business Cycle Measurement and Analysis, **TD No. 395 (February 2001)**.

P. ANGELINI, *Liquidity and announcement effects in the euro area*, Giornale degli economisti e annali di economia, **TD No. 451 (October 2002).**

S. MAGRI, *Italian households' debt: The participation to the debt market and the size of the loan*, Empirical Economics, **TD No. 454 (October 2002)**.

P. ANGELINI, P. DEL GIOVANE, S. SIVIERO and D. TERLIZZESE, *Monetary policy in a monetary union: What role for regional information?*, International Journal of Central Banking, **TD No. 457 (December 2002)**.

L. MONTEFORTE and S. SIVIERO, *The Economic Consequences of Euro Area Modelling Shortcuts*, Applied Economics, **TD No. 458 (December 2002).**

L. GUISO and M. PAIELLA,, *Risk aversion, wealth and background risk*, Journal of the European Economic Association, **TD No. 483 (September 2003).**

G. FERRERO, *Monetary policy, learning and the speed of convergence*, Journal of Economic Dynamics and Control, **TD No. 499 (June 2004).**

F. SCHIVARDI e R. TORRINI, *Identifying the effects of firing restrictions through size-contingent Differences in regulation*, Labour Economics, **TD No. 504 (giugno 2004)**.

C. BIANCOTTI, G. D'ALESSIO and A. NERI, *Measurement errors in the Bank of Italy's survey of household income and wealth*, Review of Income and Wealth, **TD No. 520 (October 2004)**.

D. Jr. MARCHETTI and F. Nucci, *Pricing behavior and the response of hours to productivity shocks,* Journal of Money Credit and Banking, **TD No. 524 (December 2004).**

L. GAMBACORTA, *How do banks set interest rates?,* European Economic Review, **TD No. 542 (February 2005).**

P. ANGELINI and A. Generale, *On the evolution of firm size distributions*, American Economic Review, **TD No. 549 (June 2005).**

R. FELICI and M. PAGNINI,, *Distance, bank heterogeneity and entry in local banking markets*, The Journal of Industrial Economics, **TD No. 557 (June 2005).**

M. BUGAMELLI and R. TEDESCHI, *Le strategie di prezzo delle imprese esportatrici italiane*, Politica Economica, **TD No. 563 (November 2005).**

S. DI ADDARIO and E. PATACCHINI, *Wages and the city. Evidence from Italy*, Labour Economics, **TD No. 570 (January 2006)**.

M. BUGAMELLI and A. ROSOLIA, *Produttività e concorrenza estera*, Rivista di politica economica, **TD No. 578 (February 2006).**

PERICOLI M. and M. TABOGA, *Canonical term-structure models with observable factors and the dynamics of bond risk premia*, **TD No. 580 (February 2006).**

E. VIVIANO, *Entry regulations and labour market outcomes. Evidence from the Italian retail trade sector*, Labour Economics, **TD No. 594 (May 2006)**.

S. FEDERICO and G. A. MINERVA, *Outward FDI and local employment growth in Italy*, Review of World Economics, Journal of Money, Credit and Banking, **TD No. 613 (February 2007).**

F. BUSETTI and A. HARVEY, *Testing for trend*, Econometric Theory **TD No. 614 (February 2007).**

V. CESTARI, P. DEL GIOVANE and C. ROSSI-ARNAUD, *Memory for Prices and the Euro Cash Changeover: An Analysis for Cinema Prices in Italy*, In P. Del Giovane e R. Sabbatini (eds.), The Euro Inflation and Consumers' Perceptions. Lessons from Italy, Berlin-Heidelberg, Springer, **TD No. 619 (February 2007).**

B. ROFFIA and A. ZAGHINI, *Excess money growth and inflation dynamics*, International Finance, **TD No. 629 (June 2007)**.

M. DEL GATTO, GIANMARCO I. P. OTTAVIANO and M. PAGNINI, *Openness to trade and industry cost dispersion: Evidence from a panel of Italian firms*, Journal of Regional Science, **TD No. 635 (June 2007)**.

A. CIARLONE, P. PISELLI and G. TREBESCHI, *Emerging Markets' Spreads and Global Financial Conditions*, Journal of International Financial Markets, Institutions & Money, **TD No. 637 (June 2007).**

S. MAGRI, *The financing of small innovative firms: The Italian case*, Economics of Innovation and New Technology, **TD No. 640 (September 2007)**.