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PRODUCTIVITY SHOCKS, STABILIZATION POLICIES AND THE DYNAMICS OF NET FOREIGN ASSETS

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Productivity Shocks, Stabilization Policies and the Dynamics of Net Foreign Assets*

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Abstract

In this paper we investigate the role of macroeconomic stabilization policies for the international transmission of productivity shocks and their effects on the external sector. We develop a two-country *stochastic* Dynamic New-Keynesian "perpetual youth" model of the business cycle with incomplete international financial markets. Our OLG structure implies stationary net foreign asset dynamics and allows for a thorough analysis of the interaction of monetary policy with non-balanced budget fiscal policy.

We derive the dynamic and cyclical properties of fiscal deficit feedback rules and their implications for net foreign assets dynamics. Our results imply that the degree of "fiscal discipline", i.e. the extent to which the fiscal rule responds to debt dynamics, is crucial for the dynamics of net foreign assets. We show that under a counter-cyclical fiscal rule with low fiscal discipline temporary positive productivity shocks may result in substantial deteriorations of the Net Foreign Asset position in the medium run. This result crucially hinges on the interplay among nominal rigidities, non-balanced budget fiscal policy, and the wealth effects on consumption that are implied by our OLG structure.

JEL classification: E43, E44, E52, E58
Key words: Fiscal Deficit, Net Foreign Assets, DSGE Models, Monetary and Fiscal Policy.

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In an increasingly internationally linked world, it is essential to understand how different shocks are transmitted and counteracted by macroeconomic policy. In this paper we study the role that fiscal and monetary policies play in the international transmission of productivity shocks, focusing in particular on the implications for net foreign assets (NFA) dynamics. We build a small-scale qualitative open economy Dynamic Stochastic General Equilibrium (DSGE) framework featuring a "perpetual youth" demand side which allows for a non-trivial role for non-balanced-budget (non-BB) fiscal policies and stationary NFA dynamics.

In the New Open Economy Macroeconomics (NOEM) literature, featuring nominal rigidities and monopolistic competition, several contributions have been devoted to analyze monetary policy. However, in the same literature, the analysis of fiscal behavior has been mainly limited to the analysis of balanced budget (BB) policies.[1] The benchmark open economy DSGE model in the NOEM tradition moves from the seminal *Redux* model of Obstfeld and Rogoff (1995). This framework, in its baseline specification, is not suitable to study the implications of non-BB fiscal policies for NFA dynamics. Building on the joint assumption of infinitely-lived household and frictionless financial markets, indeed, this model results in non-stationary net foreign asset dynamics; moreover Ricardian Equivalence limits the range of fiscal policies that can be analyzed.

This paper overcomes both these limitations by means of a single modification of the demand side. In particular, we include a "perpetual youth" structure into the baseline small-scale DSGE-NOEM model. In our economy, agents are randomly replaced by newcomers holding zero financial wealth. The interaction between agents with accumulated financial wealth and such newcomers implies a link between aggregate consumption and financial wealth dynamics that allows to pin down the NFA position in the steady state. In addition, it also implies a role for non-BB fiscal policies since Ricardian Equivalence no longer applies.

In the paper, we take a positive approach and do not deal with welfare or normative issues. Optimal monetary and fiscal policies have been widely investigated in the NOEM tradition into the standard framework of the representative agent. In our context, the different demographic structure makes the analysis relevantly more difficult and research still did not produce any generally valid result. Nevertheless, we think that a comparative assessment of the qualitative macrodynamics associated with plausible and simple policy rules maybe an important step in the construction of a larger scale quantitative model that can be used for macroeconomic policy evaluation. Our positive investigation considers different monetary and fiscal policy rules. As regards monetary policy, we study a simple Taylor rule based on the control of domestic price inflation and exchange rate policies explicitly targeting the stabilization of NFA by means of an aggressive managed floating. Given that we do not derive an optimal monetary policy, the benchmark chosen for our policy investigation is a zero-inflation policy guaranteeing price stability. This choice can be justified by observing that price stability is indeed (although differently defined from an empirical perspective) the stated objective of many Central Banks. Moreover, price stability is also the optimal policy in the closed economy version of the standard New Keynesian model (Woodford, 2003) as well as in some open

[1] A non-exhaustive list of some recent contributions includes Beetsma–Jensen (2005), Benigno–De Paoli (2006), Ferrero (2006), Galí–Monacelli (2006), Ganelli (2005) and Gnocchi–Rovelli (2007).

economy versions of the same theoretical framework.[2] As regards fiscal policy, we compare counter-cyclical feedback rules characterized by having a primary surplus responding to output gap and debt dynamics with balanced budget policies implying debt stability. While the latter have been investigated in the literature, scarce attention has been devoted to non balanced budget feedback rules. However, there is widely documented emprical evidence, both in the US and the Euro Area, that fiscal policy has been often conducted in a countercyclical way (Galí–Perotti, 2003), without even mentioning the huge discretionary fiscal measures undertaken by most countries following the severe 2008-2009 world recession. A qualitative study of the propagation mechanism induced by different fiscal feedback rules on the main macroeconomic variables following productivity shocks can be useful for future more extensive evaluations of the empirical performance of such rules along the lines of Favero–Monacelli (2005) and Manasse (2006).

We show that counter-cyclical fiscal policies characterized by scarce concern for debt dynamics can amplify the effects of structural distortions in the transmission of productivity shocks, thereby inducing external imbalances. This result may hence contribute to the debate on the role of macroeconomic stabilization policies and their effects on international financial markets, that spurred in the aftermath of the recent financial crisis (see, among the others, Taylor, 2008). In our model, the degree of fiscal discipline plays a crucial role for NFA and exchange rate dynamics. We define the degree of fiscal discipline as the responsiveness of the counter cyclical fiscal rule to the stock of outstanding debt. If the government follows a counter-cyclical deficit rule with scarce fiscal discipline (as the empirical evidence for the U.S. suggests), then *positive* productivity shocks may result in *deteriorations* of the external position in the medium run. We investigate in detail the role of different features of the model in determining this result.

The paper is organized as follows. After a brief section dealing with related literature, in section 2 we lay out the model. In section 3 we describe the linearized version of the model and the chosen benchmark allocation. Section 4 introduces monetary and fiscal policy, and discusses the implications of different policy regimes for NFA dynamics and the other main endogenous variables. Section 5 analyzes the relative contribution of several features of the model in driving our main result. Section 6, finally, summarizes and concludes.

1 Related Literature

The analysis of the international transmission of idiosyncratic productivity shocks and their effects on the external balance dates back to Backus, Kehoe and Kydland (JPE, 1992), who extend the standard Real Business Cycle model to a two-country world, and evaluate the implications for the international business cycle. They show that a positive temporary productivity shock on the home economy deteriorates the external balance through an inflow of physical capital for about four quarters, while it implies a persistent positive balance afterwards. The same International RBC model (IRBC) is used by Kollmann (1998) to study the role of international asset market structure

[2]See Benigno and Benigno (2003) for a discussion of the conditions under which price stability is an optimal monetary policy regime in open economies.

in the transmission of productivity shocks to the external balance in the U.S. in the 1980's. He shows that a positive productivity shock to the domestic economy can induce a persistent external deficit only as long as international asset markets are incomplete *and* the idiosyncratic shock is permanent. A temporary productivity shock (even as persistent as implied by an autoregressive coefficient of .95) can only imply an external surplus, no matter what the degree of asset market completeness is.

In this paper, we take on the issue of the international transmission of productivity shocks within the small-scale Dynamic New Keynesian (DNK) model, widely used for the analysis of monetary policy, in order to understand what is the role of the several frictions and departures that it implies with respect to the IRBC framework. Moreover, our OLG structure allows us to integrate the analysis of the international transmission of productivity shocks with different fiscal policy regimes.

From a methodological perspective, our work is related to other contributions that have tried, in the NOEM literature, to overcome the shortcoming of non-stationary NFA. Such contributions took two main routes to tackle this problem.

The first is the one taken by Benigno (2009), Erceg, Guerrieri and Gust (2005) and Hunt and Rebucci (2005) among others, who choose to retain the fully stochastic Representative Agent (RA) structure of the demand side. However, they introduced additional frictions (in the form of intermediation costs) in the international financial markets, in order to introduce a link between consumption and NFA dynamics and thus achieve stationarity. More specifically, Benigno (2009) introduces adjustment costs of holding foreign assets in excess with respect to some fixed and exogenous "reference level". In this approach, the steady state level of financial wealth is pinned down uniquely by such (arbitrarily chosen) "reference level". Our OLG structure, instead, has the benefit of exploiting heterogeneity in households, and it implies that the steady state level of financial wealth depends upon structural parameters related to preferences and policy.

The second approach, followed by Cavallo and Ghironi (2002), Smets and Wouters (2002) and Ganelli (2005) among the others, maintains a frictionless financial structure while introducing non-Ricardian agents, so that the evolution of financial wealth affects consumption and stationarity is again achieved. In order to solve the model, however, these contributions take a step back to the *Redux* model by restoring a perfect foresight environment. This approach provides a natural environment for the analysis of non-BB fiscal policies. However it does not allow to say much about the cyclical properties of different rules, because of the perfect-foresight assumption.[3]

We combine and integrate some of the elements of the approaches described above, and set up a *fully stochastic* DGE-NOEM framework in which consumers are non-ricardian and financial markets are frictionless. We develop a stochastic two-country perpetual youth model with imperfect competition and nominal rigidities that draws on Di Giorgio and Nisticò (2007), extended to allow for endogenous determination of NFA dynamics and fiscal deficits.

[3]A third "technical" device to link the dynamics of NFA to consumption has been recently exploited by Ferrero–Gertler–Svennson (2007), who make the time-discount factor endogenous to the level of average consumption, in an otherwise standard RA two-country DSGE model.

The main results of our paper can be compared with those of several related contributions.

Cavallo and Ghironi (2002) study the dynamic effects of unexpected productivity shocks for exchange rate determination and NFA dynamics, in a perfect foresight framework in which fiscal policy is always balanced budget. They show that an unexpected positive productivity shock deteriorates the external balance only as long as it is permanent, while it always appreciates the exchange rate. This result crucially depends on a monetary policy rule responding to the level of output – rather than the output gap – which implies an increase in the interest rate (and therefore an appreciation of the exchange rate) following a positive productivity shock. In our economy, the deterioration of the NFA position can instead derive also from temporary shocks, through an amplification mechanism triggered by non-balanced budget fiscal policy when the degree of fiscal discipline is low. Since monetary policy responds to the output gap, moreover, the exchange rate depreciates on impact, and appreciates in the transition, as the NFA position turns negative.

Our work can be also related to studies that have recently tried to explain the sustained deterioration of the U.S. external position in the 90's, in the face of a stronger productivity growth. Fogli and Perri (2006) use a two-country IRBC model with borrowing limits, and argue that the higher relative reduction in the volatility of structural shocks in the U.S. produced a fall in precautionary savings, able to account for about 20% of the observed deterioration in the U.S. external balance. To the same aim, Hunt and Rebucci (2005) simulate the quantitative GEM model of the IMF and show that a number of additional features are still needed to match the observed dynamics, in particular uncertainty and learning about the persistence of productivity shocks and a consumers portfolio preference shift in favor of U.S. assets. Both these papers build upon the assumption of balanced-budget fiscal policy.

Our small-scale framework is clearly not suited to replicate the observed facts or give any quantitative evaluation of actual macroeconomic dynamics, given its highly parsimonious structure. Nevertheless, we show that countercyclical fiscal policy, when interacting with nominal rigidities and simple monetary policy rules, can imply an amplification mechanism strong enough to make even temporary productivity shocks translate into substantial external imbalances. This result suggests that the fiscal-policy dimension is an important element for the analysis of NFA dynamics, and should be properly accounted for even in large-scale quantitative models.

2 A DSGE Two-Country Model with Incomplete Markets

In our economy, two countries, H and F, are structurally symmetric and of equal size. Each household, in each country, supplies labor inputs to firms and demands a bundle of consumption goods consisting of both non-tradable domestic goods, and tradable (home and foreign) goods. On the production side, a continuum of firms in the interval $[0, \xi]$ produces perishable, differentiated goods that are tradable across countries, while firms in the interval $(\xi, 1]$ produce differentiated non-traded goods. To assign a relevant role to monetary policy we introduce nominal rigidities by assuming that both domestic and foreign firms, both in the tradable and non-tradable sectors, each period face an exogenous probability of optimally changing the price of their good (Calvo, 1983).

2.1 The Demand-Side.

The demand-side of our economy is a discrete-time stochastic version of the perpetual youth model introduced by Blanchard (1985) and Yaari (1965) and extended to a two-country DSGE setting by Di Giorgio and Nisticò (2007). Each period, in each country, a constant share γ of traders in financial markets are randomly replaced by newcomers holding zero-financial wealth; from that period onward, these newcomers start trading in financial markets and face a constant probability γ of being replaced as the next period begins.[4]

2.1.1 Intertemporal Allocation.

Consumers have log-utility preferences over consumption and leisure, supply labor services to domestic firms active in the tradable (T) and non-tradable (N) sectors and demand consumption goods. Each consumer in each country is endowed with an equal amount of non-tradable shares of the domestic firms. Moreover, consumers allocate savings among a full set of domestic state-contingent private securities, and two riskless assets, issued by the two governments to finance their budget deficits. These bonds are the only internationally tradable assets.

Let $\mathcal{E}_t$ be the nominal exchange rate defined as the domestic price of foreign currency, $T_t^i(j)$ denote real lump-sum taxes levied by the fiscal authority of country i on household j, and variables with a superscript * denote nominal values. In particular, $B_{k,t}^{*i}(j)$ denotes holdings of risk-free assets held by generation j living in country i, in nominal terms and denominated in the currency of country k, for $i,k = H,F$. $\mathcal{B}_{k,t}^*(j)$ denotes cohort j's holdings of the portfolio of state-contingent assets, denominated in domestic currency, for which the relevant Stochastic Discount Factor (SDF) pricing one-period claims is $\mathcal{F}_{t,t+1}^i$.[5] Each household enters each period with a stock of bond holdings which also pay off the return on the insurance contract *à la* Blanchard (1985): $\gamma/(1-\gamma)$.[6]

Formally, the problem faced at time 0 by household $j < 0$ living in country H is to choose a sequence $\{C_t^H(j),\, L_{T,t}^H(h,j),\, L_{N,t}^H(h,j),\, \mathcal{B}_{H,t}^{*H}(j),\, B_{H,t}^{*H}(j),\, B_{F,t}^{*H}(j)\}_{t=0,h\in[0,1]}^{\infty}$ that maximizes

$$E_0 \sum_{t=0}^{\infty} \beta^t (1-\gamma)^t \left[\log C_t^H(j) + \delta \int_0^{\xi} \log\left(1 - L_{T,t}^H(h,j)\right) \mathrm{d}h + \delta \int_{\xi}^{1} \log\left(1 - L_{N,t}^H(h,j)\right) \mathrm{d}h \right]$$

subject to a sequence of budget constraints of the form

$$P_t^H C_t^H(j) + E_t\{\mathcal{F}_{t,t+1}^H \mathcal{B}_{H,t}^*(j)\} + B_{H,t}^{*H}(j) + \mathcal{E}_t B_{F,t}^{*H}(j) \leq \frac{1}{1-\gamma}\Omega_{t-1}^{*H}(j) + P_t^H \varpi_t^H(j), \qquad (1)$$

[4] For a thorough discussion of this mechanism, see Castelnuovo and Nisticò (2010), and Nisticò (2010). An alternative interpretation of parameter γ is that it implies an expected duration of trading in financial markets ($1/\gamma$) which can be seen as the effective planning horizon. See also Leith and Wren-Lewis (2000), Leith and vonThadden (2004), and Piergallini (2006).

[5] The stochastic discount factor is unique within each country, given the assumption of complete domestic markets.

[6] Competitive insurance companies collect the financial wealth of the agents that exit financial markets and redistribute it among those that are still active, in proportion to their own accumulated wealth. In an open economy setting, this implies that all assets (both domestic and foreign) left over by replaced agents are redistributed only domestically, so that the international distribution of financial wealth is not affected.

in which $\Omega^{*H}_{t-1}(j)$ denotes the stock of financial wealth carried over from period $t-1$

$$\Omega^{*H}_{t-1}(j) \equiv \left[(1+r^H_{t-1})B^{*H}_{H,t-1}(j) + \mathcal{E}_t(1+r^F_{t-1})B^{*H}_{F,t-1}(j) + \mathcal{B}^*_{H,t-1}(j)\right], \tag{2}$$

and $\varpi^H_t(j)$ collects the sources of non-tradable income, coming from labor services in the two sectors, profits from the monopolistic firms in the two sectors, D^i_t, and public transfers, T^i_t:[7]

$$\varpi^H_t(j) \equiv \int_0^{\xi} W^H_{T,t}(h)L^H_{T,t}(h,j)\,\mathrm{d}h + \int_{\xi}^{1} W^H_{N,t}(h)L^H_{N,t}(h,j)\,\mathrm{d}h + D^i_t - T^i_t.$$

Households living in country F face an analogous problem.

Optimality with respect to bond holdings implies the familiar Uncovered Interest Parity (UIP) condition:

$$E_t\left\{\mathcal{F}^H_{t+1}\left[\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t}(1+r^F_t) - (1+r^H_t)\right]\right\} = 0, \tag{3}$$

and the equilibrium level of the riskless returns of bonds denominated in the currency of country i:

$$E_t\mathcal{F}^i_{t,t+1} = (1+r^i_t)^{-1}. \tag{4}$$

In equilibrium, the SDF for k–period ahead contingent claims for generic country $i = H, F$ is the individual Intertemporal Marginal Rate of Substitution (IMRS) in consumption

$$\mathcal{F}^i_{t,t+k} = \beta\frac{P^i_t C^i_t(j)}{P^i_{t+k}C^i_{t+k}(j)},$$

which implies the following individual Euler equation:

$$\beta P^i_t C^i_t(j) = E_t\mathcal{F}^i_{t,t+1}P^i_{t+1}C^i_{t+1}(j). \tag{5}$$

It is important to notice that the individual Euler equation above is identical to the one we would obtain in the standard RA framework. This result is a direct implication of the insurance contract *à la* Blanchard, which effectively sterilizes the uncertainty connected to the possibility of being randomly replaced in the financial market. Accordingly, the agents that are active in financial markets behave *individually* exactly as if they were infinitely-lived, pursuing full intertemporal consumption smoothing. They do not, however, all have the same amount of consumption. Indeed, individual consumption of agents belonging to cohort j can be shown to depend, in equilibrium, upon their own accumulated stock of financial and human wealth:[8]

$$C^i_t(j) = \varsigma\left[\frac{1}{1-\gamma}\Omega^i_{t-1}(j) + \mathcal{H}^i_t(j)\right], \tag{6}$$

where $\mathcal{H}^i_t(j) \equiv E_t\left\{\sum_{k=0}^{\infty}\mathcal{F}^i_{t,t+k}(1-\gamma)^k\varpi^i_{t+k}(j)P^i_{t+k}/P^i_t\right\}$ is the expected discounted stream of non-tradable income and $\varsigma \equiv 1-\beta(1-\gamma)$ is the marginal propensity to consume out of total wealth.

[7] We assume, with no loss of generality, that profits from the monopolistic firms and public transfers are distributed uniformly across cohorts, regardless of their age, and therefore suppress the index j.

[8] See Di Giorgio and Nisticò (2007) for details on the derivation in a related framework.

Hence, agents belonging to different cohorts consume different levels of consumption depending on how much financial wealth they have accumulated. Such difference is particularly important with respect to agents entering the markets in the current period, who can consume only out of their human wealth – because they hold no other source of wealth: $C_t^i(t) = \varsigma \mathcal{H}_t^i(t)$.

Aggregating the equilibrium conditions across cohorts,[9] the demand side of generic country i consists of a set of labor supplies, one for each domestic brand h and sector $u = T, N$

$$\delta P_t^i C_t^i = W_{u,t}^i(h) \left(1 - L_{u,t}^i(h)\right), \tag{7}$$

the aggregate domestic budget constraint, expressed as a stochastic difference equation in aggregate financial wealth

$$E_t \mathcal{F}_{t,t+1}^i \Omega_t^{*i} = P_t^i \varpi_t^i + \Omega_{t-1}^{*i} - P_t^i C_t^i, \tag{8}$$

and the state equation for aggregate consumption

$$P_t^i C_t^i = \sigma E_t \mathcal{F}_{t,t+1}^i \Omega_t^{*i} + \frac{1}{\beta} E_t \mathcal{F}_{t,t+1}^i P_{t+1}^i C_{t+1}^i, \tag{9}$$

in which $\sigma \equiv \gamma \frac{1-\beta(1-\gamma)}{\beta(1-\gamma)}$.

Equation (9) describes the dynamic path of aggregate consumption consistent with the optimal behavior of households, and derives from aggregation of the individual Euler equations (5). In the RA setup, aggregation of the individual Euler equations is straightforward because all agents are identical and they all consume the same amount of consumption. This implies that, in equilibrium, the individual and average IMRS in consumption are the same, and equal to the SDF. Hence, individual consumption smoothing carries over in aggregate terms and the time–t level of average consumption is related only to the discounted value expected for $t + 1$. This case is nested in our framework when the turnover rate γ is zero.

When there is turnover in financial markets between agents with accumulated wealth and agents with no assets, the aggregation of the individual Euler equations is more cumbersome. To relate current *aggregate* consumption with the expected future level, indeed, we have to account for the wedge between the average consumption of the agents that survive in the market over time, and that of the newcomers that will enter the market in the future: if there is public debt outstanding, since newcomers enter the markets holding none of it, their level of consumption will be relatively lower. This wedge can be shown to be proportional to the current stock of financial wealth.[10] This is the sense in which our economy is non-Ricardian: public consumption (either domestic or foreign) financed through new public debt enlarges the wedge between average consumption of old

[9]The aggregate *per-capita* levels across cohorts for each generation-specific variable $X(j)$ are computed as the weighted average $X_t \equiv \sum_{j=-\infty}^{t} \gamma(1-\gamma)^{t-j} X_t(j)$, for both countries. Given that no financial wealth is held by agents entering financial markets in the current period, moreover, the following holds:

$$\sum_{j=-\infty}^{t} \gamma(1-\gamma)^{t-j} \Omega_{t-1}(j) = (1-\gamma)\Omega_{t-1}.$$

[10]See Nisticò (2010) for the derivation and a detailed discussion of this point in a related framework.

agents and that of newcomers and thereby affects the dynamics of aggregate consumption;[11] public consumption financed in balanced budget, on the other hand, since the consequent tax burden is shared by all – and only – the agents currently in the economy, does not affect the dynamics of aggregate consumption because it does not induce an intertemporal asymmetry in the consumption profile of agents belonging to different cohorts.

Therefore, while *individual* equilibrium conditions are identical to the RA case, the equilibrium dynamic path for *aggregate* consumption is generally different. As a consequence, what drives the financial wealth effect is not the finiteness of individual agents' planning horizon, because the effect of this feature is sterilized by the insurance mechanism *à la* Blanchard (1985), as shown by equation (5). The distortion to aggregate consumption dynamics, instead, is entirely due to the heterogeneity in households, and the consequent consumption dispersion between the newcomers with zero-wealth and the old traders with accumulated wealth.[12] Such distortion is captured by the first term on the right-hand side of equation (9), and is more relevant the higher γ.

Moreover, this feature establishes a link between financial wealth and aggregate consumption, which is necessary to pin down the equilibrium NFA position in the steady state and induce stationary dynamics outside the steady state. As the rate of replacement γ approaches zero, the wealth effect fades out and we converge to the RA set up, in which fluctuations in financial wealth are neutral for the dynamics of aggregate consumption and the NFA dynamics is nonstationary.

2.1.2 Intratemporal Allocation.

At time t, for each household living in country i and belonging to cohort j, real consumption is given by the following composite bundle of tradable and non-tradable goods:

$$C_t^i(j) = \left[\xi^{\frac{1}{\eta}} C_{T,t}^i(j)^{\frac{\eta-1}{\eta}} + (1-\xi)^{\frac{1}{\eta}} C_{N,t}^i(j)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{10}$$

in which $\eta > 0$ is the elasticity of substitution between tradable and non-tradable goods, and ξ is the share of tradable goods in the consumption bundle. In turn, consumption of tradable goods is a CES bundle of domestic and imported goods:

$$C_{T,t}^i(j) = \left[\kappa_i^{\frac{1}{\theta}} C_{H,t}^i(j)^{\frac{\theta-1}{\theta}} + (1-\kappa_i)^{\frac{1}{\theta}} C_{F,t}^i(j)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}, \tag{11}$$

in which $\theta > 0$ measures the elasticity of substitution between Home and Foreign tradable goods, $\kappa_H = 1 - \kappa_F = \kappa > .5$ reflects the degree of home-bias in consumption and $C_{H,t}^i(j)$ and $C_{F,t}^i(j)$ result from Dixit-Stiglitz-aggregation of the consumption goods produced in the two countries:

$$C_{H,t}^i(j) = \left[\xi^{-1/\epsilon} \int_0^{\xi} C_{H,t}^i(h,j)^{\frac{\epsilon-1}{\epsilon}} dh\right]^{\frac{\epsilon}{\epsilon-1}} \quad C_{F,t}^i(j) = \left[\xi^{-1/\epsilon} \int_0^{\xi} C_{F,t}^i(f,j)^{\frac{\epsilon-1}{\epsilon}} df\right]^{\frac{\epsilon}{\epsilon-1}} \tag{12}$$

[11] Since we are considering a two-country economy, the usual argument relating the non-Ricardian effects of non-balanced budget fiscal policy to the intertemporal budget constraint of the government is no longer necessarily valid, since the the latter does not need to be satisfied at the country level but only at the aggregate, world level. See Benigno (2005) for a discussion of this point.

[12] This argument is crucial for the interpretation of the nature of γ. See Nisticò (2010) for a discussion.

where $\epsilon > 1$ is the elasticity of substitution between any two differentiated goods. We assume such elasticity, reflecting the degree of market power, to be the same across countries and across sectors. Therefore, consumption of non-tradable goods obeys:

$$C^H_{N,t}(j) = \left[(1-\xi)^{-1/\epsilon}\int_\xi^1 C^H_{N,t}(h,j)^{\frac{\epsilon-1}{\epsilon}}dh\right]^{\frac{\epsilon}{\epsilon-1}} \quad C^F_{N,t}(j) = \left[(1-\xi)^{-1/\epsilon}\int_\xi^1 C^F_{N,t}(f,j)^{\frac{\epsilon-1}{\epsilon}}df\right]^{\frac{\epsilon}{\epsilon-1}}. \tag{13}$$

Total expenditure minimization yields the price indexes for tradable goods of brand i', produced in country i and sold in country k, for $i' = h, f$ and $i, k = H, F$

$$P^i_{k,t} = \left[\xi^{-1}\int_0^\xi P^i_{k,t}(i')^{1-\epsilon}di'\right]^{\frac{1}{1-\epsilon}} \tag{14}$$

and the consumer-price index (CPI) for country i

$$P^i_t = \left[\xi(P^i_{T,t})^{1-\eta} + (1-\xi)(P^i_{N,t})^{1-\eta}\right]^{\frac{1}{1-\eta}}, \tag{15}$$

in which the overall price levels of tradable and non-tradable goods are, respectively:

$$P^i_{T,t} = \left[\kappa_i(P^i_{H,t})^{1-\theta} + (1-\kappa_i)(P^i_{F,t})^{1-\theta}\right]^{\frac{1}{1-\theta}} \qquad P^i_{N,t} = \left[(1-\xi)^{-1}\int_\xi^1 P^i_{N,t}(i')^{1-\epsilon}di'\right]^{\frac{1}{1-\epsilon}}. \tag{16}$$

2.1.3 The Government

We assume that the government in each country consumes an exogenously given amount of domestic goods, both tradable and non-tradable:

$$G^i_{i,t}(i') = \left(\frac{P^i_{i,t}(i')}{P^i_{i,t}}\right)^{-\epsilon} G^i_t \qquad G^i_{N,t}(i') = \left(\frac{P^i_{N,t}(i')}{P^i_{N,t}}\right)^{-\epsilon} G^i_t, \tag{17}$$

for $i = H, F$ and $i' = h, f$. The government of country i can finance its own consumption G^i_t by levying lump-sum taxes T^i_t to domestic households and by issuing nominal debt denominated in local currency $B^*_{i,t}$. This implies the following flow budget constraint for the fiscal authority, in nominal per-capita terms:

$$B^*_{i,t} = (1 + r^i_{t-1})B^*_{i,t-1} + Z^{*i}_t, \tag{18}$$

where Z^{*i}_t denotes the nominal primary deficit for country i, defined as

$$Z^{*i}_t \equiv \xi P^i_{i,t}G^i_t + (1-\xi)P^i_{N,t}G^i_t - P^i_t T^i_t. \tag{19}$$

2.1.4 Market Clearing and the Dynamics of NFA

Define the Terms of Trade (ToT) as the relative price of foreign tradable goods in terms of home tradable goods ($\mathcal{S}_t \equiv P^i_{F,t}/P^i_{H,t}$),[13] and denote the relative price of non-tradable to tradable goods

[13] Notice that, given the definition of terms of trade, the price levels of tradable goods imply the following relative prices:

$$\frac{P^H_{T,t}}{P^H_{H,t}} = \left[\kappa + (1-\kappa)\mathcal{S}_t^{1-\theta}\right]^{\frac{1}{1-\theta}} \equiv h(\mathcal{S}_t) \qquad \frac{P^F_{T,t}}{P^F_{F,t}} = \left[\kappa + (1-\kappa)\mathcal{S}_t^{\theta-1}\right]^{\frac{1}{1-\theta}} \equiv f(\mathcal{S}_t).$$

by $\mathcal{V}_{i,t} \equiv P^i_{N,t}/P^i_{T,t}$, in each country.[14] Finally, we assume that prices of the differentiated goods are set in the producer's currency (Producer Currency Pricing, PCP), implying that the Law of One Price (LOP) holds, and therefore:

$$P^H_{i,t}(i') = \mathcal{E}_t P^F_{i,t}(i') \qquad\qquad P^H_{i,t} = \mathcal{E}_t P^F_{i,t}.$$

Accordingly, the brand-specific demand for tradable good h, produced in country H is

$$\begin{aligned} &Y^d_{H,t}(h) \equiv C^H_{H,t}(h) + C^F_{H,t}(h) + G^H_{H,t}(h) = \\ &= \left(\frac{P^H_{H,t}(h)}{P^H_{H,t}}\right)^{-\epsilon} \left[\kappa \left(\frac{P^H_{H,t}}{P^H_{T,t}}\right)^{-\theta} \left(\frac{P^H_{T,t}}{P^H_t}\right)^{-\eta} C^H_t + (1-\kappa) \left(\frac{P^F_{H,t}}{P^F_{T,t}}\right)^{-\theta} \left(\frac{P^F_{T,t}}{P^F_t}\right)^{-\eta} C^F_t + G^H_t\right], \end{aligned} \tag{20}$$

while that for the domestic non-tradable brands is:

$$Y^d_{N,t}(h) \equiv C^H_{N,t}(h) + G^H_{N,t}(h) = \left(\frac{P^H_{N,t}(h)}{P^H_{N,t}}\right)^{-\epsilon} \left[\left(\frac{P^H_{N,t}}{P^H_t}\right)^{-\eta} C^H_t + G^H_t\right]. \tag{21}$$

Using the above, and the familiar Dixit-Stiglitz aggregators

$$Y_{H,t} \equiv \left[\xi^{-1} \int_0^{\xi} Y^s_{H,t}(h)^{\frac{\epsilon-1}{\epsilon}}\, dh\right]^{\frac{\epsilon}{\epsilon-1}} \qquad\qquad Y^H_{N,t} \equiv \left[(1-\xi)^{-1} \int_{\xi}^{1} Y^s_{N,t}(h)^{\frac{\epsilon-1}{\epsilon}}\, dh\right]^{\frac{\epsilon}{\epsilon-1}},$$

market clearing implies the following aggregate demands for goods produced in country H:[15]

$$Y_{H,t} = \kappa \left(\frac{P^H_{H,t}}{P^H_{T,t}}\right)^{-\theta} \left(\frac{P^H_{T,t}}{P^H_t}\right)^{-\eta} C^H_t + (1-\kappa) \left(\frac{P^F_{H,t}}{P^F_{T,t}}\right)^{-\theta} \left(\frac{P^F_{T,t}}{P^F_t}\right)^{-\eta} C^F_t + G^H_t \tag{22}$$

$$Y^d_{N,t} = \left(\frac{P^H_{N,t}}{P^H_t}\right)^{-\eta} C^H_t + G^H_t. \tag{23}$$

Given asymmetry in the consumption bundle of tradable goods ($\kappa_H = 1 - \kappa_F = \kappa$) and the existence of non-tradable goods, the model implies endogenous deviations from purchasing power parity, and therefore fluctuations in the Real Exchange Rate (RER), which depend on both the terms of trade $\mathcal{S}$ and the relative price of non-tradable goods in the two countries $\mathcal{V}_i$:

$$Q_t \equiv \frac{\mathcal{E}_t P^F_t}{P^H_t} = \left[\frac{\kappa \mathcal{S}_t^{1-\theta} + (1-\kappa)}{\kappa + (1-\kappa)\mathcal{S}_t^{1-\theta}}\right]^{\frac{1}{1-\theta}} \left[\frac{\xi + (1-\xi)\mathcal{V}^{1-\eta}_{F,t}}{\xi + (1-\xi)\mathcal{V}^{1-\eta}_{H,t}}\right]^{\frac{1}{1-\eta}}. \tag{24}$$

[14] Given the definition of relative price of non-tradables $\mathcal{V}_{i,t}$, the CPI can also be expressed as:

$$P^i_t = P^i_{T,t} v(\mathcal{V}_{i,t}) = P^i_{N,t} \frac{v(\mathcal{V}_{i,t})}{\mathcal{V}_{i,t}},$$

where

$$v(\mathcal{V}_{i,t}) \equiv \left[\xi + (1-\xi)\mathcal{V}^{1-\eta}_{i,t}\right]^{\frac{1}{1-\eta}}$$

[15] Analogous expressions hold for country F.

Define the Net Foreign Asset position, in real terms, as the difference between domestic holdings of foreign assets and foreign holdings of domestic ones, evaluated in units of domestic consumption: $\text{NFA}_t^H \equiv Q_t B_{F,t}^H - B_{H,t}^F = \Omega_t^H - B_{H,t}$. Accordingly, market clearing and the aggregate budget constraint (8) imply

$$\text{NFA}_t^H = \frac{(1+r_{t-1}^H)}{1+\pi_t^H}\text{NFA}_{t-1}^H + \text{NX}_t^H, \tag{25}$$

in which π_t^H denotes the CPI net inflation rate and NX_t^H defines the domestic external trade balance:

$$\text{NX}_t^H \equiv \xi \frac{P_{H,t}^H}{P_t^H}\left(Y_{H,t} - G_t^H\right) - \xi \frac{P_{T,t}^H}{P_t^H} C_{T,t}^H. \tag{26}$$

Market clearing in the external sector, finally, implies $\text{NFA}_t^H + Q_t \text{NFA}_t^F = 0$.

2.2 The Supply-Side.

Each firm, in each country and each sector, has access to a stochastic linear technology:

$$Y_{i,t}(i') = A_t^i L_{i,t}^i(i') \qquad\qquad Y_{N,t}^i(i') = A_t^i L_{N,t}^i(i')$$

with $i' = h, f$ and $i = H, F$. A_t^i is a productivity shock, which is country specific but common across sectors, within a given country. Firms choose labor demand in a competitive labor market by minimizing their total real costs subject to the technological constraint. In equilibrium, the real marginal cost for country i's firms in the tradable and non-tradable sectors is, respectively:

$$MC_{i,t}^i = \frac{W_{i,t}^i}{P_{i,t}^i A_t^i} \qquad\qquad MC_{N,t}^i = \frac{W_{N,t}^i}{P_{N,t}^i A_t^i}. \tag{27}$$

Using the brand-specific demand functions (20)–(21) and aggregating across domestic brands, we get the aggregate production functions for country i and the two sectors:

$$Y_t^i \Xi_{i,t}^i = A_t^i L_{i,t}^i \qquad\qquad Y_{N,t}^i \Xi_{N,t}^i = A_t^i L_{N,t}^i,$$

in which $\Xi_{i,t}^i \equiv \xi^{-1}\int_0^\xi \left(P_{i,t}^i(i')/P_{i,t}^i\right)^{-\epsilon} \mathrm{d}i'$ captures (second-order) relative price dispersion among firms in the tradable sector, and $L_{i,t}^i \equiv \xi^{-1}\int_0^\xi L_{i,t}^i(i')\,\mathrm{d}i'$ is the aggregate per-capita amount of hours worked in country i in that sector.[16]

Equilibrium in the labor market then implies that real marginal costs for country i equal

$$MC_{i,t} = \frac{\delta C_t^i}{A_t^i - Y_{i,t}\Xi_{i,t}^i}\frac{P_t^i}{P_{i,t}^i} \qquad\qquad MC_{N,t}^i = \frac{\delta C_t^i}{A_t^i - Y_{N,t}^i \Xi_{N,t}^i}\frac{P_t^i}{P_{N,t}^i} \tag{28}$$

for the tradable and non-tradable sector, respectively.

[16] Analogously, for the non-tradable sector we have:

$$\Xi_{N,t}^i \equiv (1-\xi)^{-1}\int_\xi^1 \left(P_{N,t}^i(i')/P_{N,t}^i\right)^{-\epsilon}\mathrm{d}i' \qquad\qquad L_{N,t}^i \equiv (1-\xi)^{-1}\int_\xi^1 L_{N,t}^i(i')\,\mathrm{d}i'.$$

In the spirit of the NOEM tradition, we assume nominal rigidities, in the form of firms that set prices according to Calvo's (1983) staggering mechanism, with $1-\vartheta_s^i$ being the probability for each firm in country $i = H, F$ and sector $s = T, N$ to optimally adjust its price. In equilibrium, this assumption implies a set of familiar New Keynesian Phillips Curves (NKPC), one for each sector in each country.

3 The Linear Model

We linearize the model around a symmetric, zero-inflation/zero-deficit steady state, in which all relative prices, given symmetry, are equal to one ($\mathcal{S} = Q = \mathcal{V}_i = 1$) , and the external balance is zero ($\text{NX}^i = \text{NFA}^i = 0$, for $i = H, F$).[17] Let $x_t \equiv \log X_t - \log X$ denote the log-deviation of variable X from such steady state,[18] and s_c denote the inverse consumption share in output ($s_c \equiv Y/C$). Moreover, let a superscript ^{R} denote home relative variables, $x^R \equiv x^H - x^F$, and a superscript ^{W} denote world aggregates, $x^W \equiv .5(x^H + x^F)$.

Define total domestic output as the average of tradable and non-tradable output:

$$y_t^H \equiv \xi y_{H,t} + (1-\xi) y_{N,t}^H. \tag{29}$$

The demand for home tradable goods $y_{H,t}$ depends positively on the terms of trade s_t, the relative price of non-tradables in the two countries $\nu_{i,t}$, aggregate private consumption in the two countries c_t^i and domestic public consumption g_t^H:

$$y_{H,t} = \frac{1}{s_c}\Big[2\theta\kappa(1-\kappa)s_t + \eta(1-\xi)\Big(\kappa\nu_{H,t} + (1-\kappa)\nu_{F,t}\Big) + \kappa c_t^H + (1-\kappa)c_t^F\Big] + g_t^H; \tag{30}$$

the demand for domestic non-tradable goods, in turn, is decreasing in their relative price, and increasing in aggregate domestic – both private and public – consumption:

$$y_{N,t}^H = \frac{1}{s_c}\Big[c_t^H - \eta\xi\nu_{H,t}\Big] + g_t^H. \tag{31}$$

Using the equations above, and a linear approximation of equation (25), the dynamics of Net Foreign Assets can be expressed, in terms of the position of country H, as:

$$\text{nfa}_t^H = \frac{1}{\beta}\text{nfa}_{t-1}^H + \xi(1-\kappa)\Big[(2\kappa\theta - 1)s_t - c_t^R\Big] + \zeta\nu_t^R, \tag{32}$$

in which

$$\zeta \equiv \eta\frac{1-\xi}{2}\big[\xi(2\kappa - 1) - 1\big].$$

The response of the NFA position to a deterioration the of terms of trade is, thus, the result of two competing effects. On the one side, an increase in s_t implies a trade deficit because it reduces the real value of domestic production, relative to absorption (negative absorption effect: $-\xi(1-\kappa)s_t$),

[17] We present the main equations characterizing the Home economy; analogous ones apply to the Foreign economy.

[18] Except $g_t^i \equiv \frac{G}{Y}\log(G_t^i/G)$, $\tau_t^i \equiv \frac{T}{Y}\log(T_t^i/T)$. Moreover, given the assumption of zero-primary deficit in steady state, we define $z_t^i \equiv \frac{Z_t^i}{C}$, $\omega_t^i \equiv \frac{\Omega_t^i}{C}$, $\text{nfa}_t^i \equiv \frac{\text{NFA}_t^i}{C}$, $\text{nx}_t^i \equiv \frac{\text{NX}_t^i}{C}$ and $b_{i,t} \equiv \frac{B_{i,t}}{C}$.

and implies a deterioration of the NFA position. On the other side, the increase in s_t makes domestic goods more competitive in the international markets, implying a switch towards home goods and a consequent improvement in the NFA position (positive switching effect: $2\xi(1-\kappa)\kappa\theta s_t$). The more substitutable Home and Foreign goods in the utility of consumers (the higher θ), the more relevant the positive switching effect: if $2\kappa\theta > 1$, the latter dominates and a deterioration of the terms of trade implies an improvement in the NFA position.

Consumption in country H evolves following a linear approximation of equation (9)

$$c_t^H = E_t c_{t+1}^H - (r_t^H - E_t \pi_{t+1}^H - \rho) + \sigma(\text{nfa}_t^H + b_{H,t}), \tag{33}$$

in which an explicit role is played by total financial wealth $\omega_t^H = \beta^{-1}(\text{nfa}_t^H + b_{H,t})$, and $\rho = -\log\beta$ denotes the steady state net interest rate. The stock of domestic debt follows

$$b_{H,t} = \frac{1}{\beta} b_{H,t-1} + z_t^H, \tag{34}$$

in which the real primary deficit is

$$z_t^H = s_c(g_t^H - \tau_t^H) - (s_c - 1)\xi(1-\kappa)s_t. \tag{35}$$

Taking the difference of equation (33) and its foreign counterpart and imposing market clearing ($\text{nfa}_t^H + \text{nfa}_t^F = 0$) yields the equation governing the dynamics of the cross-country consumption differential:

$$c_t^R = E_t c_{t+1}^R - E_t \Delta q_{t+1} + 2\sigma \text{nfa}_t^H + \sigma b_t^R. \tag{36}$$

The equation above is key, as it shows the implications of non-Ricardian agents for the dynamics of NFA: as long as $\sigma > 0$, indeed, the NFA position affects the cross-country consumption differential, through wealth effects, and thereby allows the "cross-feedback" of equations (32) and (36) that ensures stationarity in NFA dynamics.

As to prices, CPI inflation depends on domestic and imported inflation

$$\pi_t^H = \pi_{H,t} + \xi(1-\kappa)\Delta s_t, \tag{37}$$

in which overall domestic PPI inflation is a weighted average of the sectoral producer-price inflation rates

$$\pi_{H,t} = \xi \pi_{H,t}^H + (1-\xi)\pi_{N,t}^H, \tag{38}$$

and the terms of trade account for imported inflation, according to:

$$s_t = s_{t-1} + \Delta e_t + \pi_{F,t}^F - \pi_{H,t}^H. \tag{39}$$

In turn, the producer-price inflation rates evolve according to familiar NKPC

$$\pi_{H,t}^H = \beta E_t \pi_{H,t+1}^H + \lambda_T^H m c_{H,t}^H \qquad \pi_{N,t}^H = \beta E_t \pi_{N,t+1}^H + \lambda_N^H m c_{N,t}^H, \tag{40}$$

in which the elasticity to real marginal costs is $\lambda_u^H \equiv \frac{(1-\vartheta_u^H)(1-\beta\vartheta_u^H)}{\vartheta_u^H}$, for $u = T, N$.

The relative price of non-tradable goods follows

$$\nu_{H,t} = \nu_{H,t-1} + \pi^H_{N,t} - \pi^H_{H,t} - (1-\kappa)\Delta s_t. \tag{41}$$

Finally, the model implies endogenous fluctuations in the RER:

$$q_t = (2\kappa - 1)s_t - (1-\xi)\nu^R_t. \tag{42}$$

The two terms in the equation above capture the two sources of failure of Purchasing Power Parity (PPP) in our model: home-bias in consumption and non-tradable goods. The first relates the RER to the terms of trade, the second to the cross-country difference in the relative price of nontradables. The latter, in particular, breaks the link between the real exchange rate and the terms of trade (were all goods tradable, $\xi = 1$, we would obtain a perfect correlation between q and s). When $\xi = 1$ and there is no home-bias in consumption ($\kappa = .5$), finally, PPP is restored and the RER is constant.

3.1 The Benchmark Allocation

The environment just described is subject to three kinds of distortions. Two of them are common to the RA framework: monopolistic competition and nominal rigidities. The third one is specific to our non-Ricardian economy, and is stronger the larger the stock of aggregate financial wealth.[19]

We take as our benchmark the global allocation arising in the absence of all distortions: the Flexible-price Balanced-budget Equilibrium (FBE). The "flexible-price" feature of the FBE rules out the distortions due to monopolistic competition and nominal rigidities, to a first-order approximation.[20] The "zero-deficit" (balanced-budget) feature sterilizes – at the world level – the third distortion, due to the consumption dispersion across agents: since it implies a zero-stock of global financial wealth, the dynamics of global consumption is undistorted, as can be seen by aggregating across countries equation (33) and imposing the market-clearing and zero-deficit restrictions. In the Flexible-price Balanced-budget Equilibrium, therefore, the global fluctuations induced by structural shocks reflect the efficient dynamic response of the economy, and our model converges to an IRBC model with no physical capital.

In the FBE, marginal costs in both countries and both sectors are equal to their steady state level at all times. Denoting with an over-bar a variable in such FBE, the above restriction on marginal costs implies (aggregating across countries and across sectors) the equilibrium level of global consumption,

$$\bar{c}^W_t = \frac{s_c}{s_c + \varphi}\left[(1+\varphi)a^W_t - \varphi g^W_t\right], \tag{43}$$

[19] Notice that the dynamic distortion due to the non-Ricardian structure does not depend on the financial structure of international markets. Indeed, even under complete international markets the presence of a fiscal authority issuing debt would still induce wealth effects on aggregate consumption.

[20] To rule out both distortions in the non-linear model, indeed, we would also need to assume that the fiscal authority subsidizes employment, to correct the inefficiently low level of output induced by monopolistic competition. Since this distortion is static, however, it does not affect the log-linear representation of the model, and we can disregard it with no effect on our results.

and the global resource constraint: $\overline{y}_t^W = s_c^{-1}\overline{c}_t^W + g_t^W$. In turn, the equilibrium dynamics of net foreign assets (in terms of H's position) is described by

$$\overline{\text{nfa}}_t^H = \frac{1}{\beta}\overline{\text{nfa}}_{t-1}^H + \xi(1-\kappa)\Big[(2\kappa\theta - 1)\overline{s}_t - \overline{c}_t^R\Big] + \zeta\overline{\nu}_t^R, \tag{44}$$

while that of the cross-country consumption differential by

$$\overline{c}_t^R = E_t\overline{c}_{t+1}^R - E_t\Delta\overline{q}_{t+1} + 2\sigma\overline{\text{nfa}}_t^H. \tag{45}$$

At the global level, consumption dynamics in the FBE is unaffected by fluctuations in financial wealth, as shown by equation (43). However, *at the country level*, changes in the Net Foreign Asset position due to a non-zero trade balance enter the state equation for relative consumption. This is crucial, as it ensures the "cross-feedback" of equations (44) and (45) inducing stationarity in the NFA dynamics also in the FBE.

4 Stabilization Policy and NFA Dynamics

In this section we use our stylized two-country economy to asses the dynamic and cyclical implications of stabilization policy, focusing in particular on the transmission of country-specific productivity shocks to the external sector.

4.1 Stabilization Policy

By "stabilization policy", we mean a macroeconomic policy that aims at counteracting fluctuations of real variables around the FBE, induced by the structural distortions. In this paper we do not address normative issues related to welfare, and therefore do not derive the optimal monetary and fiscal policies. Instead, we take a positive approach and limit our analysis to compare the theoretical implications of alternative simple fiscal and monetary rules.[21]

As benchmark policy regime, we choose a "Price and Debt Stability" (PDS) mix that implements the Flexible-price Balanced-budget allocation described in the previous section. As to monetary policy, we follow Benigno (2009) and consider a policy of zero (overall) domestic inflation in both countries and at all times, which implements the flexible-price allocation. As to fiscal policy, in turn, the most natural candidate is a policy of zero deficit in both countries and at all times, which ensures that the dynamic path of global consumption is undistorted. The PDS, therefore, requires

$$\pi_{i,t} = z_t^i = 0, \tag{46}$$

for $i = H, F$ and at all times t. This is also the benchmark policy regime implicitly assumed in most of the literature analyzing open-economy DNK monetary models, in which the fiscal authorities are typically assumed to run balanced budgets.

[21] Fully articulated normative and welfare analysis, and the solution of the associated issues implied by the population structure, is an ambitious target left for further research.

As to monetary policy, we then contrast the dynamic and cyclical properties of two alternative simple rules to those of the benchmark. The first simple rule is a standard interest rate rule of the kind introduced by Taylor (1993), which has the nominal interest rate respond to deviations of the overall domestic inflation rate $\pi_{H,t}$ and the domestic output gap $x_t^H \equiv y_t^H - \overline{y}_t^H$ from the zero targets (DITR):

$$r_t^H = \rho + \phi_\pi^H \pi_{H,t} + \phi_x^H x_t^H + u_{m,t}^H, \tag{47}$$

in which $u_{m,t}^H$ are white noises capturing pure monetary policy shocks.

Since our main focus wants to be on the effects of stabilization policy on the external sector, we study, as a second alternative, a "managed floating" regime pursuing stabilization of the NFA dynamics around its FBE level, by inducing appropriate adjustments of the real exchange rate (MFLO):

$$q_t = -\chi(\text{nfa}_{t-1}^H - \overline{\text{nfa}}_{t-1}^H) + u_{m,t}^H, \tag{48}$$

in which the response coefficient $\chi > 0$ measures the degree of aggressiveness towards the external target.[22]

As to fiscal policy, we consider as an alternative specification, a simple rule that has the government set the primary deficit following a (possibly counter-cyclical) fiscal rule of the kind[23]

$$z_t^H = \mu_x^H x_t^H + \mu_b^H b_{t-1}^H + u_{z,t}^H. \tag{49}$$

The use of primary-deficit feedback rules has become increasingly popular to characterize discretionary fiscal policy in recent empirical analyses (See, among the others, Favero and Monacelli, 2005, Galí and Perotti, 2003, and Manasse, 2006). We use such specification to investigate the dynamic and cyclical implications of fiscal policy as a stabilization tool, and set the target primary deficit as a counter-cyclical response to the output gap and the stock of public debt (i.e. $\mu_x^H, \mu_b^H < 0$): μ_x^H captures the extent to which fiscal policy is used to stabilize output around its benchmark FBE level – the degree of counter-cyclicality; μ_b^H measures the extent to which the dynamics of public debt is of concern to the fiscal authorities – the degree of "fiscal discipline". We focus on these policy coefficients, and study how changing their magnitude affects the NFA position of a given country.

4.2 Parameterization

We identify the U.S. as the H country and the Euro Area as the F country, and parameterize the model on a quarterly frequency, following previous studies and convention. Specifically, the intertemporal discount factor β is set at 0.99, implying a steady-state net quarterly interest rate ρ of about 1%.[24] The rate of replacement γ was set at 0.1, consistently with the evidence for the

[22] Notice the use of a real exchange rate rule, as an instrument to stabilize NFA dynamics. In a previous version of the paper, which does not feature deviations from PPP, we also investigated the implications of a more standard nominal exchange rate peg and of a Taylor rule responding to CPI inflation. See Di Giorgio and Nisticò (2008).

[23] We focus only on "passive" (in the sense of Leeper, JME 1991) or implementable (in the sense of Schmitt-Grohe and Uribe, 2006) fiscal rules.

[24] Since we concentrate on a symmetric steady state the values reported in the text are meant to refer to both countries as well as to the world economy.

U.S. recently provided, in a related framework, by Castelnuovo and Nisticò (2010). The degree of monopolistic competition is taken from Rotemberg and Woodford (1998), $\epsilon = 7.66$, which implies an average markup of 15%, while the probability for firms of having to keep their price fixed for the current quarter was set at 0.75 for both countries and both sectors, consistently with estimates provided for the U.S. by Smets and Wouters (2007), and implying that prices are revised on average once a year. Parameter s_c was set equal to 1.25, implying a ratio of public consumption to output of about 20%. As to the steady-state Frisch elasticity of labor supply, $1/\varphi$, there is wide controversy about the value that should be assigned to this parameter. The empirical microeconomic literature suggests values for φ ranging from .1 to .5 (see Card, 1994, for a survey), while business cycle literature mostly uses values greater than 1 (see e.g. Cooley and Prescott, 1995). We choose a baseline value of $\varphi = .5$, consistently with the microevidence.[25] Following the evidence and arguments in Obstfeld and Rogoff (2005), we set the elasticity of substitution between tradable and non-tradable goods to $\eta = 1$, the share of tradable goods in the consumption bundle to $\xi = 0.25$, the share of domestic goods in the bundle of tradables to $\kappa = 0.7$, and the elasticity of substitution between domestic and foreign goods to $\theta = 1.5$.[26]

As to the stochastic shocks, we allow for international propagation of productivity shocks and therefore assume that they evolve as a stationary VAR(1) process: $\mathbf{a}_t = \mathbf{P}_a \mathbf{a}_{t-1} + \mathbf{u}_{at}$, where $\mathbf{a} \equiv [a^H \quad a^F]'$. To calibrate persistence and volatilities, we estimate the VAR using quarterly HP-filtered data on labor productivity in the U.S. and the Euro Area for the period spanning from 1970:1 to 2005:4.[27] The values obtained are reported in Table 1 (t-statistics in parenthesis). As the table shows, we find some evidence of an international stochastic relation between productivity in the U.S. and the Euro Area, and a small positive correlation between the innovations.[28]

[25] Given the steady state restrictions, this requires a value of δ equal to 2.2. Robustness analysis did not reveal qualitative sensitivity or our results with respect to this parameter.

[26] With respect to this latter parameter there has been considerable debate over its true value, with the empirical literature providing a vast range of estimates, often dependent on the level of aggregation used. Until recently, most of the literature provided values in the range of unity (using aggregate data, see Hooper–Marquez, 2003) or much above (between 3 and 6, using disaggregated data, see Obstfeld–Rogoff, 2001 and McDaniel–Balistreri, 2003). Recently, the role of a θ lower than one has been given more attention from both a theoretical and empirical perspective, and was shown to be crucial in determining the international transmission of productivity shocks in IRBC models through the response of the terms of trade (see Corsetti–Dedola–Leduc, 2004). In our simulations, we also explored the implications of allowing for lower-than-one trade elasticity in our set up, and found that low fiscal discipline still induces a substantial worsening of the NFA position relative to the benchmark equilibrium.

[27] Data for the U.S. are taken from the U.S. Department of Labor: Bureau of Labor Statistics, "Nonfarm Business Sector: Output Per Hour of All Persons", series ID: OPHNFB; data for the Euro Area are taken from the Area-Wide Model Database, "Labour Productivity", series ID: LPROD. The latter database is available to EABCN members at http://www.eabcn.org/data/awm/index.htm. For a description of this database, see Fagan–Henry–Mestre (2001).

[28] The way we estimate the stochastic properties of productivity shocks differ from the one usually employed in the IRBC literature (see e.g. Backus, Kehoe and Kydland, 1992 and Heathcote and Perri, 2002), which implies the construction of series for productivity moving from the Solow residual and usually finds much more persistence and international spillovers than we do. Baxter and Crucini (1995), however, show that the use of data on employment rather than hours, as in Backus et al. (1992), is a potentially serious problem when comparing U.S. productivity with foreign one, especially European. Moreover, they also formally show that the series constructed by Backus et al. (1992) are indeed so persistent, that it is not possible to reject the null hypothesis of a unit root. When accounting for that, they also find much less spillovers. Since we are working with a theoretical model that is stationary by construction and does not account for unemployment, therefore, we view as more appropriate for our case to construct the relevant series for productivity by using data on hours, on the one hand, and make sure that they are stationary by HP-filtering them, on the other.

Table 1: Stochastic properties of the productivity shocks.

Shock	P_a		σ_a^i	$corr(u_a^H, u_a^F)$
a^H	**0.740**	**-0.188**	**0.0069**	**0.0802**
	(12.573)	(-2.066)		
a^F	**0.118**	**0.684**	**0.0043**	
	(3.208)	(12.099)		

Analogously, to calibrate persistence and volatility of the fiscal shocks g^i, we estimate an independent AR(1) process for each shock, using quarterly HP-filtered data on government consumption in the U.S. and the Euro Area for the available sample (1970:1 to 2005:4).[29] The values obtained are reported in Table 2. Given the structural symmetry of our framework, we follow Backus, Kehoe and Kydland (1992), among the others, and use for the benchmark simulation a symmetrized version of our estimates.[30] We therefore parameterize matrix P_a as

$$P_a = \begin{bmatrix} 0.712 & -0.035 \\ -0.035 & 0.712 \end{bmatrix}, \tag{50}$$

the standard deviations of productivity shocks as $\sigma_a^i = 0.0056$ for $i = H, F$ and the cross-country correlation using the estimated value (0.0802). As to the fiscal shocks, we set $\rho_g^i = 0.666$, and $\sigma_g^i = \sigma_z^i = 0.0060$.

Table 2: Stochastic properties of the fiscal shocks.

Shock	ρ_g^i	σ_g^i	$Adj.R^2$
g^H	**0.696**	**0.0079**	**0.5038**
	(12.012)		
g^F	**0.638**	**0.0041**	**0.4159**
	(10.056)		

4.3 The Dynamic and Cyclical Implications of Productivity Shocks

The effect of idiosyncratic productivity shocks on the international business cycle and the external sector was first studied by Backus, Kehoe and Kydland (1992), who showed that a persistent positive productivity shock at home deteriorates the current account through an inflow of physical capital. However, this negative effect is only temporary, while it implies a persistent positive external balance in the medium run. Kollmann (1998) later shows that an IRBC model can imply

[29] Data for the U.S. are taken from the Federal Reserve Economic Data, FRB of St Louis, "Real Government Consumption Expenditures & Gross Investment", series ID: GCEC96; data for the Euro Area are taken from the Area-Wide Model Database, "Government Consumption", series ID: GCR.

[30] We performed the simulations also under the asymmetric calibration implied by the estimates, without substantial effects on the results.

persistent external deficits following a positive productivity shock, but only as long as international markets are incomplete *and* the shock is permanent.[31]

Within the IRBC literature, the main story is about cross-country movements of physical capital and investment, in an environment in which prices adjust instantaneously to structural disturbances and the necessary ingredients are non-stationary (or quasi-unit root) shocks. Our model, building on the tradition of small-scale NOEM models, departs from the IRBC benchmark along two important dimensions. First, it analyzes an environment in which prices respond only sluggishly to structural shocks, thus potentially amplifying the fluctuations induced by disturbances (that are typically assumed stationary); second, it abstracts from capital accumulation and investment. Without physical capital and non-stationary shocks, indeed, the IRBC model would conclude that a positive and temporary domestic productivity shock (for home and foreign goods substitutable enough) can only imply a positive trade balance and a positive NFA position, as the only reason to trade in foreign assets is to smooth the effects of the productivity shock on consumption. Such environment is nested in our model under the benchmark regime, in which prices are perfectly flexible, as in the IRBC model.

Our main result, as we show below, is that nominal rigidities, and the consequent distortions in the transmission mechanism of structural shocks, assign a relevant role to stabilization policies, which can substantially alter the NFA dynamics relative to the flexible-price equilibrium. In particular, when fiscal policy is counter-cyclical and its degree of fiscal discipline is low, the transmission of positive productivity shocks to the external sector implies a negative NFA position in the medium run, even when these productivity shocks are only temporary.

Figures 1 and 2 display our main results. If both countries follow the benchmark "Price and Debt Stability" policy, our model replicates a stationary IRBC model with no physical capital. In this case, a domestic positive productivity shock induces a deterioration in the terms of trade (raise in s_t). The relative reduction in domestic interest rates induces a depreciation of the nominal and real exchange rate. Taxes slightly fall, to prevent the primary surplus that the deterioration of the terms of trade would otherwise induce, through the reduction of domestic relative prices – at which public purchases are made. On impact, then, the economy experiences a surplus in the trade balance, through higher competitiveness, and an improvement in the NFA position, because residents in the Home country accumulate foreign assets to optimally smooth the effects of the shock on consumption. Over time, all variables converge to their steady state levels. These patterns are shown in Figures 1 and 2, by the blue dash-dotted lines.

When prices are sticky and monetary and fiscal policy follow simple stabilization rules, the picture may be different. The solid green lines in Figures 1 and 2 reflect a scenario in which the domestic and foreign Central Banks adopt a simple Domestic Inflation Taylor rule (47) and the fiscal authorities in both countries adopt a counter-cyclical deficit rule (49), parameterized at values

[31] It is worth underlying that both papers mentioned above, as most of the ones that address this issue within the IRBC framework, have as main object of interest the trade balance *per se*, rather than the NFA position, as it is instead in our case. Nevertheless, although these objects are clearly very different from a conceptional standpoint, in our specification of the world economy they are tightly related, as equation (25) shows.

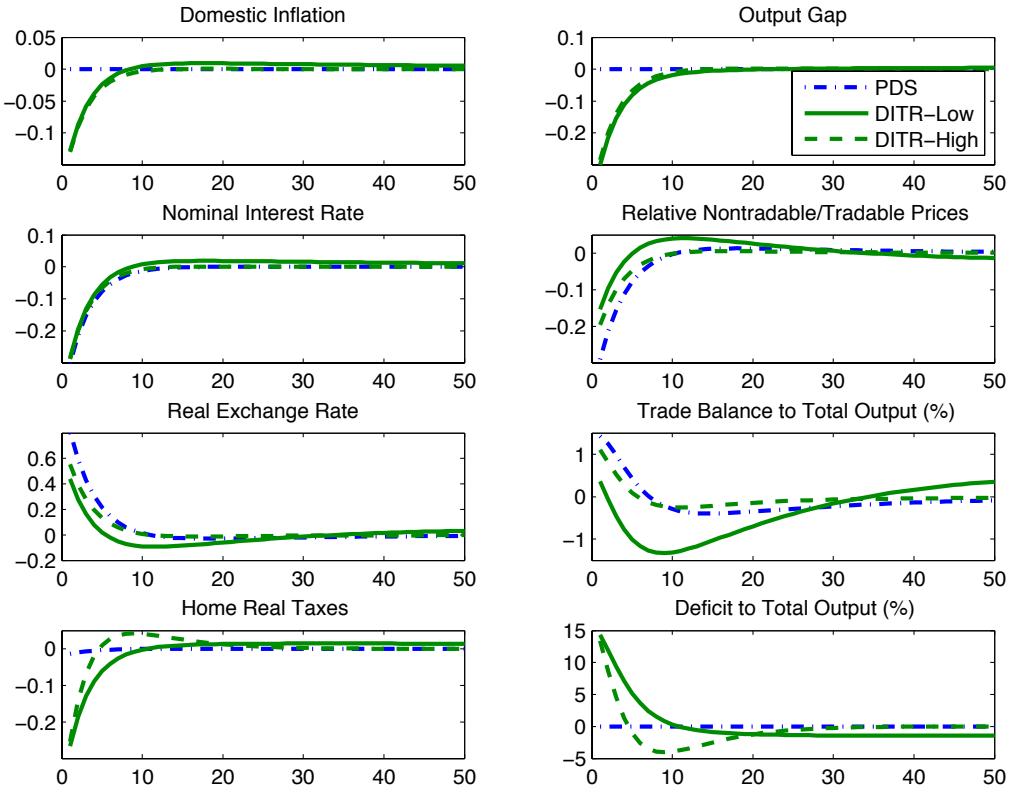

Figure 1: Dynamic response of selected domestic variables to a 1% productivity shock in Country H. **PDS**: Price and Debt Stability policy in both countries. **DITR-Low**: simple rules for both countries, low fiscal discipline for Country H. **DITR-High**: simple rules for both countries, high fiscal discipline for Country H.

consistent with the empirical evidence for the 1990's. Specifically, the response coefficients in the fiscal rules are set using values estimated by Galí and Perotti (2003): $\mu_x^H = -1.07$, $\mu_b^H = -0.015$, $\mu_x^F = -0.27$, $\mu_b^F = -0.043$. We label this scenario "DITR-Low".[32] As to the response coefficients of the monetary policy rules, we use the estimates provided for the U.S. and the Euro Area by Smets and Wouters (2003, 2007): $\phi_\pi^H = 2.040$, $\phi_x^H = 0.080$, $\phi_\pi^F = 1.688$, $\phi_x^F = 0.095$.[33]

In this scenario, a positive productivity shock in country H is only partially accommodated by the domestic Central Bank: real output does not increase as much as its potential level, so that the output gap turns negative and, through the effect on marginal costs, so does domestic inflation. On impact, the reduction in relative nominal interest rates induces a nominal and real depreciation

[32]The degree of fiscal discipline implied for the U.S. in this exercise is just as high as needed to rule out the explosive root in the law of motion of public debt. The estimate of μ_b^H that Galí and Perotti (2003) report is actually about zero. A value of zero, however, would imply in our model an indeterminate equilibrium, when associated with an active monetary policy ($\phi_\pi^i > 1$). Accordingly, we use the lowest value that ensures uniqueness of the equilibrium and stationarity of the overall dynamics. Notice, however, that this is a conservative choice, since the lower the value of μ_b^H the stronger the point we make about NFA dynamics, as we show in the next section.

[33]Our model, as all qualitative small-scale models in the NOEM tradition, has a theoretical structure that is extremely parsimonious (especially given the objectives) and is, therefore, not suited to replicate quantitatively what we observe in the data. However, we parameterize the policy rules to values estimated in recent empirical literature, to evaluate to what extent such a parsimonious structure is able to generate a transmission mechanism of some quantitative relevance.

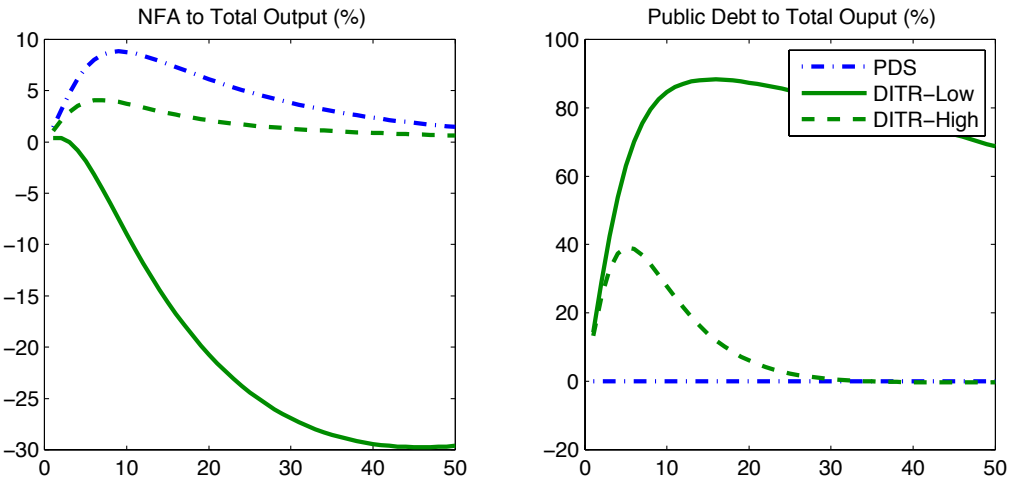

Figure 2: Dynamic response of selected domestic variables to a 1% productivity shock in Country H. **PDS**: Price and Debt Stability policy in both countries. **DITR-Low**: simple rules for both countries, low fiscal discipline for Country H. **DITR-High**: simple rules for both countries, high fiscal discipline for Country H.

of the exchange rate, while lower domestic inflation in the tradable sector drives a deterioration of the terms of trade.[34]

If the fiscal authority were running a balanced budget, the NFA position would be positive and driven by the terms-of-trade effects only. However, when fiscal policy is countercyclical and non-balanced budget, an additional transmission mechanism is triggered: the fall in the output gap, indeed, calls for a fiscal intervention that stimulates domestic production. The increase in the fiscal deficit induces accumulation of public debt. If the degree of fiscal discipline is low, the increase in the stock of public debt is not sufficiently countered by the fiscal authority and the short-run evolution of the fiscal deficit is mainly driven by the output gap. Only when the output gap is back on target, about ten quarters after the shock, the fiscal authority starts accumulating a (small) primary surplus to gradually absorb the stock of debt. Both public and private savings then fall substantially, the latter through expansionary wealth effects on consumption. After a few quarters, the fall in national savings offsets the initial deterioration of the terms of trade, and the country moves to a negative NFA position (our quantitative exercise predicts a NFA position of -20% of total output after about 20 quarters and of -30% after about 40 quarters; the trade balance is in deficit of about -1.5% of total output after about 10 quarters). These dynamics imply an increase in domestic financial wealth, which boosts domestic demand for consumption goods relatively more in the non-tradable sector (given $\xi < .5$), and after about 5 quarters reverses the negative effect of productivity on the relative price of non-tradable goods. The increase of the relative price of nontradables, in turn, implies that, after the initial depreciation, the real exchange rate starts appreciating and after about 5 quarters, as the NFA position becomes negative, it appreciates also with respect to its steady state level. [35]

[34]Not shown in the figure. An appendix with all the impulse-response functions is available upon request.

[35]The real exchange rate stays appreciated for about 20 more quarters, then it gradually depreciates to ease the

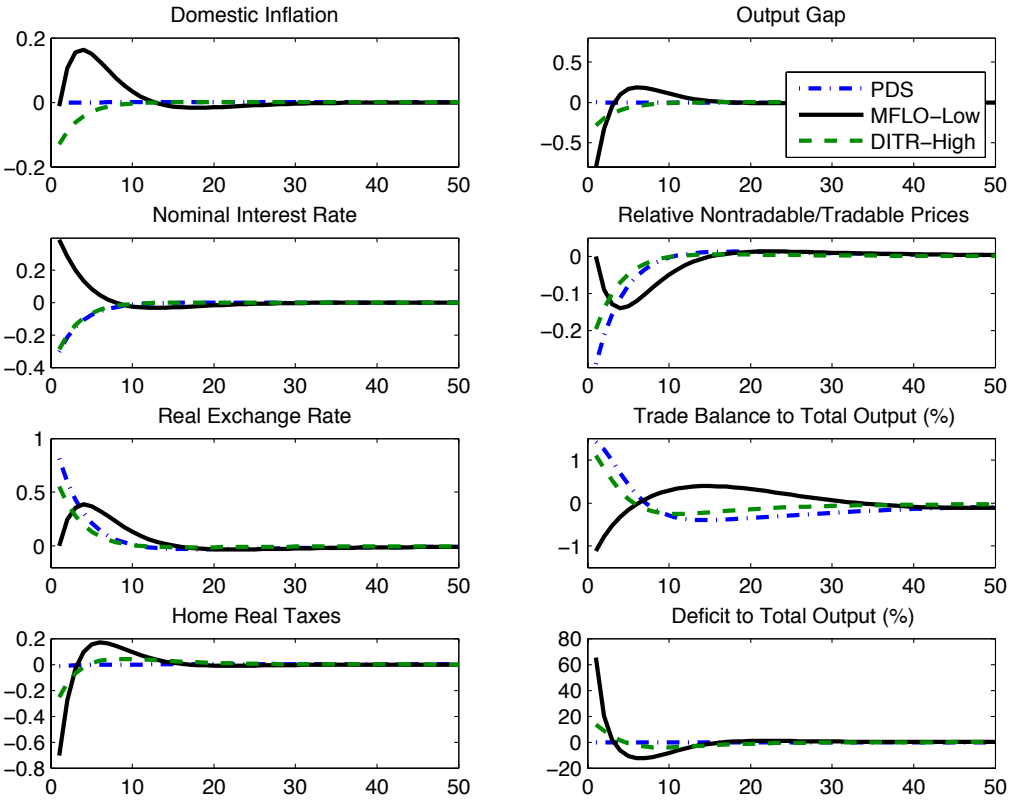

Figure 3: Dynamic response of selected domestic variables to a 1% productivity shock in Country H. **PDS**: Price and Debt Stability policy in both countries. **MFLO-Low**: deficit feedback rules for both countries, low fiscal discipline for Country H, Central Bank in country H manages the RER, in country F it follows the DITR. **DITR-High**: simple rules for both countries, high fiscal discipline for Country H.

In order to assess to what extent our main result is induced by fiscal policy, we perform a counterfactual analysis and explore the model's predictions when, *ceteris paribus*, the Home Country follows a deficit feedback rule with a higher degree of fiscal discipline. Specifically, the set $\mu_b^H = 0.15$, the value that Galí and Perotti (2003) estimate for Australia, and we label this regime "DITR-High". Its implied patterns are shown in Figures 1 and 2 by the green dashed line. When the fiscal authority is more concerned about public debt, the dynamics of the primary deficit is no longer entirely driven by the output gap: compared to the previous scenario, indeed, taxes adjust to contain the evolution of public debt, and the primary deficit turns into a substantial surplus much earlier (after about 5 quarters instead of 10). As a consequence, national savings fall by much less, and not enough to offset the terms-of-trade effect on the NFA position, which stays positive throughout the transition. The trade balance turns negative just to allow convergence of the NFA position to the long-run equilibrium. Domestic financial wealth increases less, and the demand pressures on the non-tradable sector are less intense. As a consequence, the real exchange rate does not appreciate as much and for as long as before. Overall, the economy converges to its steady

convergence of the NFA position to its long-run equilibrium. Analogously, the nominal exchange rate, depreciates on-impact and appreciates along the transition to a lower steady state (not shown).

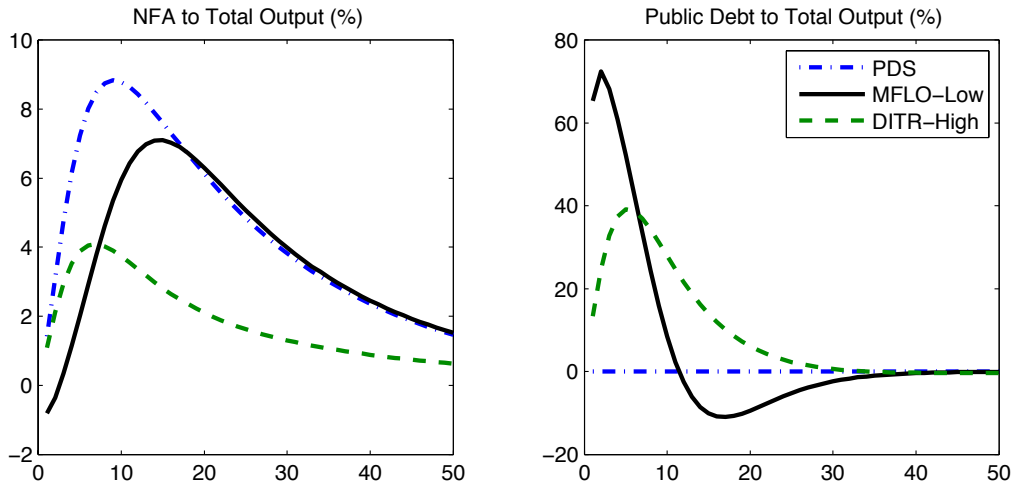

Figure 4: Dynamic response of selected domestic variables to a 1% productivity shock in Country H. **PDS**: Price and Debt Stability policy in both countries. **MFLO-Low**: deficit feedback rules for both countries, low fiscal discipline for Country H, Central Bank in country H manages the RER, in country F it follows the DITR. **DITR-High**: simple rules for both countries, high fiscal discipline for Country H.

state much more quickly than in the "DITR-Low" regime.

The implication is therefore that fiscal policy in this environment triggers an amplification mechanism that is strong enough to generate substantial external imbalances, even following temporary shocks. In particular, the degree of fiscal discipline plays a crucial role in the dynamics of the net-foreign-asset position.

We next propose an additional counterfactual, and investigate an alternative policy mix in which monetary policy manages the exchange rate so as to stabilize the external position around its FBE level. In particular, the domestic Central Bank follows the "managed floating" regime implemented by rule (48), in which we arbitrarily set the response coefficient to $\chi = 5$.[36] Fiscal policy and the foreign authorities behave as in DITR-Low regime. Solid black lines in figures 3 and 4 denote the patterns implied by this policy mix, that we label "MFLO-Low", and compare them to the benchmark PDS regime and the alternative DITR-High.

Under this policy mix, when a domestic productivity shock hits, the Central Bank raises on impact the domestic interest rate to prevent the depreciation of the exchange rate, thereby offsetting the positive effect of the productivity shock on total output and causing a deeper fall in the output gap relative to the DITR-Low regime. The initial response of total output, moreover, induces a deficit in the trade balance, and a consequent negative NFA position, which in turn triggers the monetary policy response: the interest rate falls to induce the nominal and real exchange rate depreciation needed to stabilize the external target, output and inflation increase, and the trade balance eventually turns positive, inducing a reversal in the NFA position. The level of fiscal deficit and the stock of public debt jump on impact to counteract the fall in the output gap, but revert to mean rather quickly, mainly driven by the fluctuations in the output gap (given the low degree

[36] See Di Giorgio and Nisticò (2008) for sensitivity analysis to this coefficient.

Table 3: Cyclical Properties of Alternative policy regimes, Country H

		FBE	DITR-Low	DITR-High	MFLO-Low
x^H	Output Gap	0.000	0.297	0.276	0.803
π_H	Domestic Inflation	0.000	0.116	0.108	0.319
π^H	CPI Inflation	0.062	0.126	0.116	0.328
r^H	Nominal Interest Rate	0.260	0.296	0.283	0.741
Δe	Nominal Depreciation	0.841	0.750	0.754	0.626
s	Terms of Trade	1.085	0.995	0.944	0.840
q	Real Exchange Rate	0.946	0.909	0.821	0.744
ν_H	Rel. Price of Nontradables	0.342	0.343	0.296	0.272
z^H	Primary Deficit	0.000	0.694	0.683	1.035
b_H	Public Debt	0.000	7.514	1.537	2.417
nfa^H	Net Foreign Assets	0.402	2.953	0.324	0.326

Note: Entries are Standard Deviations in %. **FBE**: Flexible-price Balanced-budget Equilibrium. **DITR-Low**: simple rules for both countries, low fiscal discipline for Country H. **DITR-High**: simple rules for both countries, high fiscal discipline for Country H. **MFLO-Low**: deficit feedback rules for both countries, low fiscal discipline for Country H, Central Bank in country H manages the RER, in country F it follows the DITR.

of fiscal discipline). Overall, the NFA position in the medium run is positive and evolves very closely to its FBE benchmark. However, to achieve this result, the Central Bank needs to induce a permanent depreciation in the nominal exchange rate and this comes at the cost of more volatile inflation and output gap.

Our results are confirmed also from an unconditional perspective, by looking at the implied volatilities. Table 3 compares the standard deviations of selected variables, in percentage points, implied by the alternative policy mixes that we investigate. The main implication of Table 3, indeed, is that, when the Central Bank follows a simple interest rate rule *à la* Taylor (1993), a relatively higher degree of fiscal discipline reduces the volatility of all the main variables of interest. This is particularly evident with respect to external imbalances: the volatility of NFA in the DITR-High regime is almost ten times smaller than in DITR-Low, and substantially closer to the FBE benchmark.

On the other hand, comparing the last two columns of Table 3 also reveals that all endogenous variables are more stable if monetary policy deals with inflation and output gap through an interest-rate rule and the fiscal authorities behave rigorously. A Central Bank choosing to stabilize the external target may reduce the volatility of NFA basically as much as a disciplined fiscal authority. However, this result would be obtained at the price of much more volatile output gap, domestic and CPI inflation, and nominal interest rates (on average three times as volatile as in the alternative DITR-High regime).

5 The Role of Distortions and Stabilization Policy

In this Section we investigate the factors behind our main result that in an environment with nominal rigidities and no physical capital, substantial external imbalances can result even from temporary productivity shocks, when fiscal policy is used as a stabilization tool and the degree of

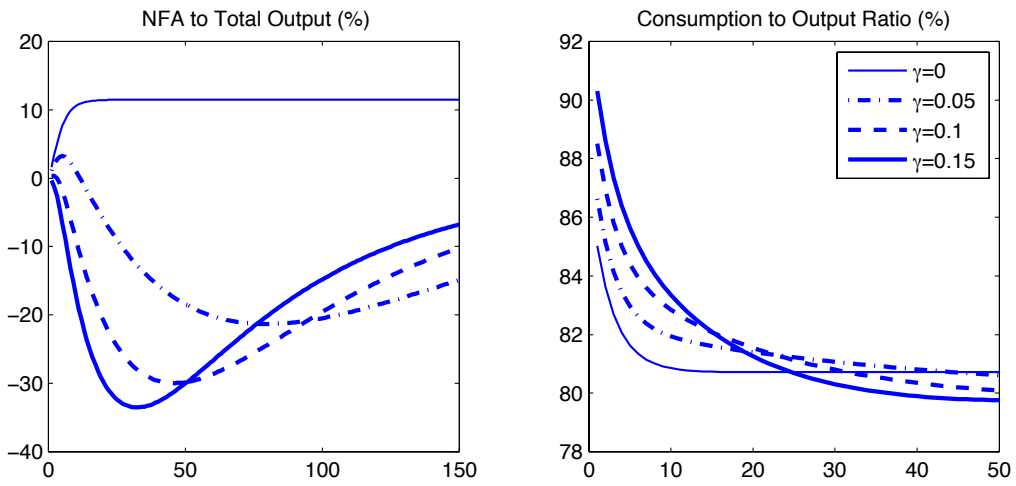

Figure 5: Dynamic response of selected domestic variables to a 1% productivity shock in Country H, for different values of the replacement rate γ, under the DITR-Low regime.

fiscal discipline is low (the DITR-Low regime). In particular, we show that such result derives from the interaction of four specific features, that are peculiar to our environment.

The first feature is the non-Ricardian structure of the economy, i.e. the interaction of agents with different levels of accumulated wealth, and the consequent wealth effects on aggregate consumption. As previously discussed, this feature allows to pin down the equilibrium NFA position in the steady state and therefore induce a stationary dynamics for the latter. This is clearly shown by Figure 5, which displays the response of the NFA position and the consumption-output ratio to a 1% positive shock in the domestic productivity for different values of the replacement rate γ. In particular, Figure 5 shows that when $\gamma = 0$, the dynamics of NFA is non-stationary: about ten quarters after the shock both the NFA and the consumption-output ratio are permanently to their new steady state levels. This is what would be implied by the baseline Representative Agent model in the NOEM tradition. As the replacement rate γ increases, however, stronger wealth effects induce stationarity in NFA dynamics. For higher γ, NFA return to their initial steady state level faster. Figure 5 also shows an additional implication: as γ increases, and wealth effects on aggregate consumption become stronger, the fiscal stance becomes more relevant for the NFA position. For given degrees of counter-cyclicality and fiscal discipline, and the consequent dynamics of public debt, indeed, stronger wealth effects on consumption imply higher consumption-output ratios in the first several quarters, thus inducing a faster reversal of the NFA position and a deeper deterioration in the transition.

The second feature that we investigate is the use of fiscal and monetary policy as a stabilization tool. Figure 6 displays the dynamic response of the NFA position and the consumption-output ratio to a 1% positive shock to domestic productivity, for different values of μ_x^H, the response coefficient in the fiscal rule to the domestic output gap. The thin line in the left panel shows that if fiscal policy is not used as a stabilization tool (μ_x^H=0), then a positive productivity shock implies a positive NFA position throughout the (stationary) transition. The intuition is straightforward:

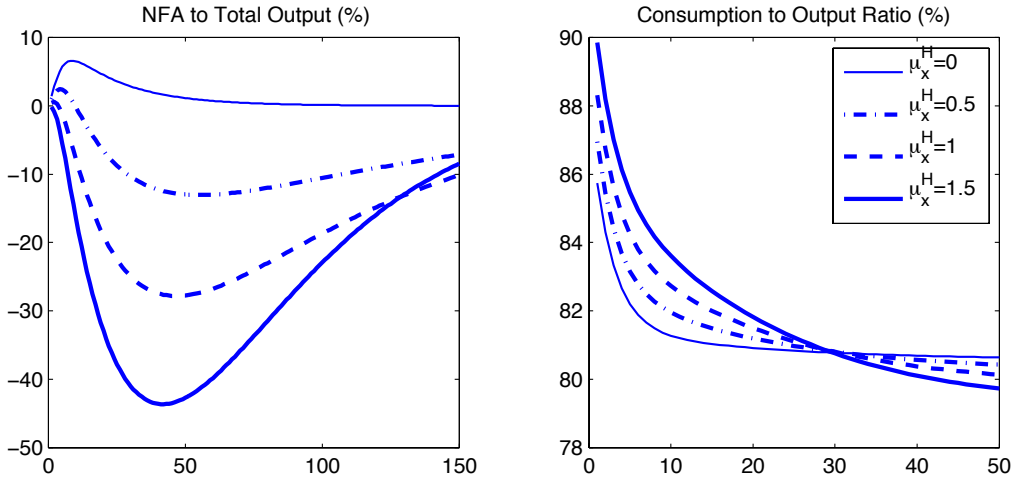

Figure 6: Dynamic response of selected domestic variables to a 1% productivity shock in Country H, for different degrees of counter-cyclicality of domestic *fiscal* policy μ_x^H, under the DITR-Low regime.

if fiscal policy is set independently of the dynamics of the output gap, then a positive productivity shock does not induce a fiscal imbalance and the dynamics of the NFA position is only driven by the terms of trade, just as if fiscal policy were balanced-budget. On the other hand, the stronger the fiscal concern towards output stabilization (the higher μ_x^H), the higher the deficit that the fiscal authority will run in response to a given fall of the output gap, and the larger the increase in the stock of public debt. For given wealth effects, then, a higher μ_x^H implies a higher consumption-output ratio, and thereby a faster and deeper reversal of the NFA position during the transition. Hence, over-stimulative *fiscal* policy can lead to higher consumption-output ratios and substantial external imbalances.

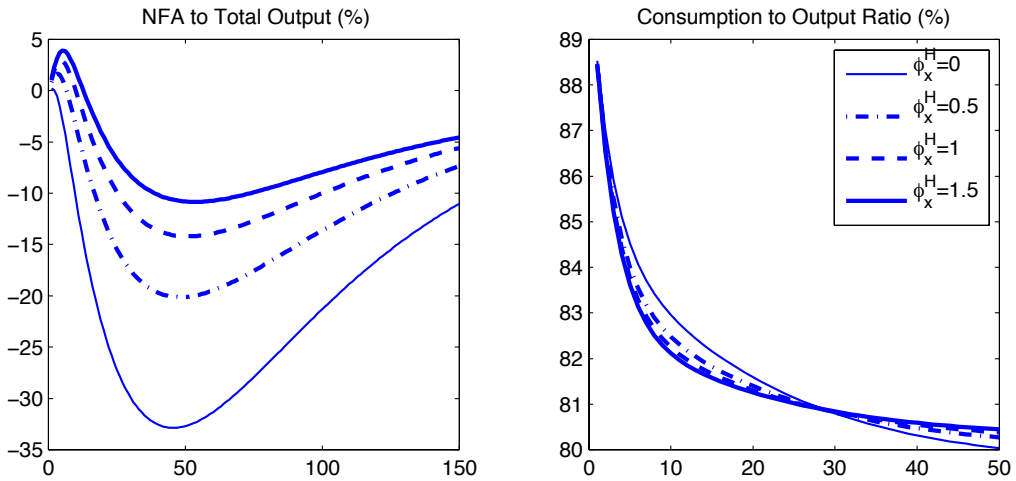

Figure 7: Dynamic response of selected domestic variables to a 1% productivity shock in Country H, for different degrees of counter-cyclicality of domestic *monetary* policy ϕ_x^H, under the DITR-Low regime.

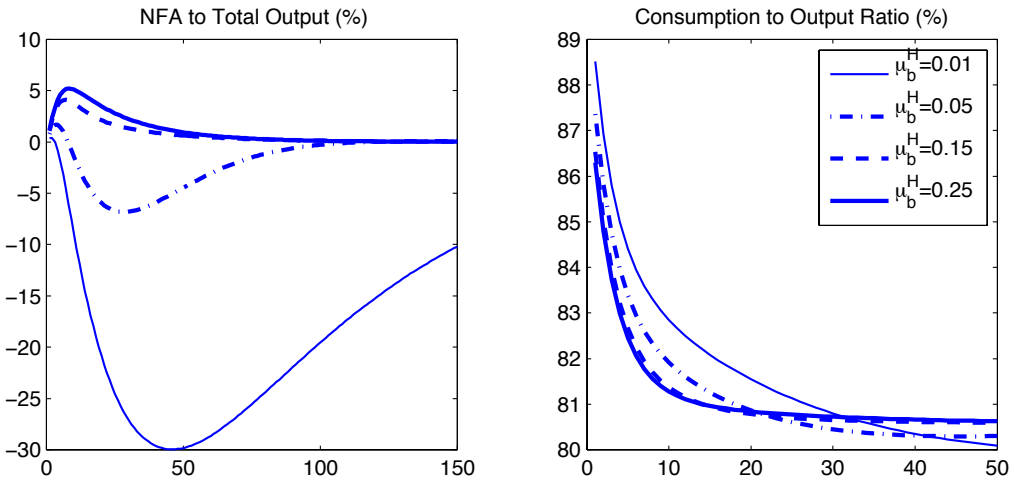

Figure 8: Dynamic response of selected domestic variables to a 1% productivity shock in Country H, for different degrees of domestic fiscal discipline μ_b^H.

The link between the degree of stabilization of the policy rules and the amplification mechanism leading to external imbalances works differently with monetary policy. In Figure 7, we repeat the previous exercise using monetary policy as a stabilization tool. We plot the dynamic response of the NFA position and the consumption-output ratio in the DITR-Low regime, for different values of the response coefficient of the monetary policy rule to the output gap, i.e. ϕ_x^H. We find that the more aggressive is the monetary policy maker (higher ϕ_x^H), the smaller the external imbalances implied by a positive productivity shock. The intuition is again clear: the more aggressive monetary policy towards the output gap, the weaker the fall in the latter following a productivity shock and, therefore, the weaker the amplification mechanism, working through countercyclical fiscal policy.

The third feature that we analyze is the quantitative relevance of the degree of domestic fiscal discipline, μ_b^H. Figure 8 shows the dynamic response of the NFA position and the consumption-output ratio for different values of μ_b^H. The thin lines correspond to the DITR-Low regime, and the dashed bold line to the DITR-High regime. As previously discussed, the left panel of Figure 8 shows that, for given wealth effects and given degree of counter-cyclicality of fiscal policy, the extent to which a temporary positive productivity shock in the Home country can induce a substantial imbalance in the NFA position is related to the degree of fiscal discipline. The higher the degree of fiscal discipline, the lower the consumption-output ratio, and the smaller and more temporary the external imbalances. Specifically, increasing the response coefficient from $\mu_b^H = 0.015$ to $\mu_b^H = 0.05$ allows to raise the lowest level in the NFA dynamics from -30% of total output after about 40 quarters to -7% after about 25 quarters.[37]

Finally, we study the role of price stickiness. Figure 9 displays the dynamic response of the NFA position and the consumption-output ratio in the DITR-Low regime, for different values of the Calvo parameter. The main message of Figure 9 is that stronger nominal rigidities impy a

[37]For the NFA position, indeed, the higher the degree of fiscal discipline, the more relevant the positive effects due to the terms-of-trade, relative to the negative ones due to falling national savings.

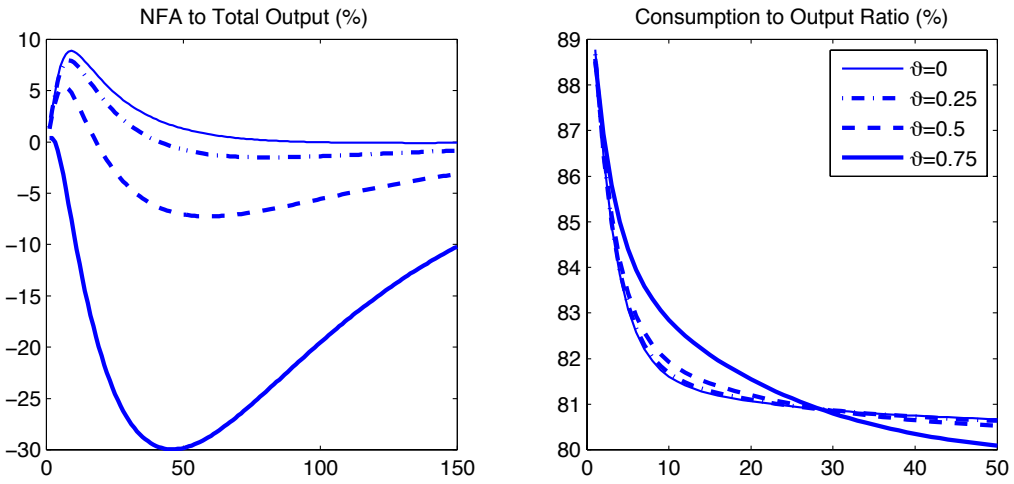

Figure 9: Dynamic response of selected domestic variables to a 1% productivity shock in Country H, for different degrees of price stickiness ϑ_s^i, for $i = H, F$ and $s = T, N$, under the DITR-Low regime.

faster and deeper fall of NFA following a positive productivity shock. The thin lines show that, under flexible prices, a positive productivity shock implies a positive NFA position, regardless of the strong degree of counter-cyclicality of fiscal policy and its low discipline, characterizing the DITR-Low regime. Price stickiness, coupled with simple monetary policy rules, has profound implications for the dynamics of inflation and the output gap: a positive productivity shock cannot be accommodated entirely in the presence of nominal rigidities. Accordingly, the stickier prices, the more the output gap will fall as a consequence of the inability of monetary policy to fully accommodate the productivity shock. A fall in the output gap, however, triggers the response of countercyclical fiscal policy. This is stronger the deeper is the fall in the output gap. Hence, for given wealth effects, and given degrees of counter-cyclicality and discipline of fiscal policy, the stickier are prices, the more the associated distortions induce an amplification mechanism, which can ultimately transform a positive and temporary productivity shock translate into substantial and negative external imbalances.

6 Concluding Remarks.

This paper presents a small-scale stochastic two-country "perpetual youth" DNK model, which implies stationary dynamics for the NFA position, and allows for endogenous interaction of the external balance with fiscal and monetary policy. Within this framework, we analyze how the use of fiscal and monetary policy as a stabilization tool affects the transmission mechanism of productivity shocks to the external sector.

We find that the interaction between wealth effects and nominal rigidities implies a relevant role of counter-cyclical fiscal policy for NFA dynamics in the medium run. In particular, we find that a fiscal authority characterized by low "fiscal discipline" – defined as the degree of responsiveness of the fiscal feedback rule to changes in the stock of public debt – can trigger an amplification mech-

anism strong enough to reverse the short-run positive terms-of-trade effects on the NFA position, and induce substantial negative imbalances.

Such amplification mechanism works through the fiscal response to the fall in the output gap, that a positive productivity shock induces (with nominal rigidities) when it is not fully accommodated by monetary policy. The consequent buildup of public debt boosts private consumption through wealth effects, the consumption-output ratio rises and overall national savings fall: domestic residents start borrowing relatively more in the international financial markets, and the aggregate NFA position turns negative.

This mechanism is stronger when consumer prices are stickier (because a given productivity shock induces a deeper fall in the output gap), when fiscal policy is more countercyclical (because a given fall in the output gap triggers a stronger fiscal response) and when the wealth effects are stronger (because a given increase in public debt induces a larger rise in the consumption-output ratio). In turn, the amplification can be muted if monetary policy is more aggressive towards output stabilization (because it reduces the effect of the productivity shock on the output gap) and if fiscal policy is more disciplined (because it contains the buildup of public debt).

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