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« Monetary and Fiscal Policy Efficiency and Coordination in an Open-Economy General Equilibrium Model with Three production Sectors »

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Monetary and Fiscal Policy Efficiency and Coordination in an Open-Economy General Equilibrium Model with Three Production Sectors

Gilbert Koenig and Irem Zeyneloglu

Abstract

The paper analyzes monetary and fiscal policy efficiency and coordination in a stochastic new open economy macroeconomics (NOEM) model with three production sectors. Some or all of these sectors can be affected by unanticipated productivity shocks which can trigger monetary and fiscal policy reactions. The uncertainty over the shocks can be symmetric or asymmetric across the two countries.

The paper first aims to assess the capacity of fiscal and monetary policy to reduce or eliminate the negative effects of unanticipated productivity shocks. Second, it evaluates the possible gains from international monetary cooperation as well as the impact of active fiscal policy on monetary policy efficiency.

The results show that monetary and fiscal policies are efficient tools of stabilization and under several conditions they can replicate the flexible-price equilibrium. However, their efficiency is not necessarily increased when both monetary and fiscal policies react to shocks at the national level. The existence of bilateral gains from monetary cooperation depends on the degree of asymmetry concerning the uncertainty over the shocks. In case of high asymmetry, monetary cooperation can be counter-productive either for the home or for the foreign country.

L'efficacité et la coordination internationale des politiques monétaires et budgétaires dans un modèle d'équilibre général à trois secteurs de production

Gilbert Koenig et Irem Zeyneloglu

Résumé

Cet article analyse l'efficacité et la coordination internationale des politiques monétaires et budgétaire dans un modèle stochastique d'équilibre général qui décrit deux économies interdépendantes comprenant chacune trois secteurs de production. Tous ces secteurs ou certains d'entre eux peuvent être affectés par des chocs de productivités non anticipés qui peuvent déclencher des réactions des autorités monétaires et budgétaires. L'incertitude sur la survenance de ces chocs peut être la même dans les deux pays ou elle peut différer d'un pays à l'autre.

L'article étudie d'abord la capacité dont disposent les politiques monétaires et budgétaires de réduire ou d'éliminer les effets négatifs des chocs de productivité. Puis, il évalue les gains éventuels que peut engendrer une coopération monétaire internationale et les incidences que peuvent avoir les politiques budgétaires actives sur l'efficacité des politiques monétaires.

L'analyse montre que les politiques monétaires et budgétaires constituent des outils de stabilisation efficaces et qu'elles peuvent, sous certaines conditions, résorber entièrement les effets négatifs des chocs sur le bien-être. Leur efficacité n'est cependant pas nécessairement accrue si elles sont mises en œuvre en même temps en réaction aux chocs. L'existence de gains provenant de la coopération monétaire internationale et bénéficiant aux deux pays dépend du degré d'asymétrie de l'incertitude sur les chocs. En cas de forte asymétrie, la coopération monétaire peut devenir contre-productive pour l'un ou l'autre pays, ce qui conduit les deux pays à adopter des stratégies non-coopératives.

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1. Introduction

Obstfeld and Rogoff (2002) extend the deterministic new open economy macroeconomics (NOEM) model of Obstfeld and Rogoff (1995) to a stochastic environment. According to the authors, this extension has the objective of providing the first analytical workhorse model that allows to determine with precision the impact of uncertainty in two-country general equilibrium models. Furthermore, the authors provide a welfare-based analysis of macroeconomic policy as a stabilization tool. They use this new framework to analyze the efficiency and coordination of monetary policy based on simple rules. Their results are similar to those suggested by traditional models such the ones analyzed by Canzoneri and Henderson (1991): gains from international monetary cooperation are generally absent or negligible.

This conclusion is reconsidered by Canzoneri et al. (2005) who extend Obstfeld and Rogoff (2002) by introducing three different production sectors in each country in order to take into account the empirically observed Balassa-Samuelson effect. They find that monetary cooperation gains may be non-negligible.

Lombardo and Sutherland (2004) extend Obstfeld and Rogoff (2002) by incorporating fiscal policies along monetary policies in a setup with only one production sector. They conclude that both monetary and fiscal policy are efficient tools for stabilization. Moreover, international monetary cooperation under price rigidity reproduces the flexible-price equilibrium regardless of the fiscal regime.

The present paper analyzes the interactions between monetary and fiscal policy, like Lombardo and Sutherland (2004), as well as their impact on the efficiency of one another. For this, we incorporate fiscal policy alongside monetary policy in the framework proposed by Canzoneri et al (2005). As such, we obtain a model that is sufficiently simple and tractable for analyzing both fiscal and monetary policy issues.

We use this framework to analyze, first, the efficiency of fiscal and monetary policy as a stabilization tool. Specifically, we assess the capacity of fiscal and monetary policy to reduce

or eliminate the negative effects of an unanticipated productivity shock affecting some or all of the sectors in each country. We see that monetary and fiscal policies are efficient tools of stabilization in all cases and under several conditions they can replicate the flexible-price equilibrium. However, their efficiency is not necessarily increased when both monetary and fiscal policy react to shocks at the national level. Our analysis differs from that of Lombardo and Sutherland by allowing sector-specific productivity shocks in each country and by introducing asymmetric uncertainty over shocks across countries.

A second purpose of the paper is to evaluate the possible gains from international monetary cooperation and to determine the impact of fiscal policies on the efficiency of monetary policies. Our results show that Canzoneri et al's conclusion of non-negligible gains from monetary cooperation is not unconditional.

The paper is organized as follows: section 2 describes the general features of the model and derives the equilibrium while section 3 defines the policy objective function. Section 4 discusses the efficiency of fiscal and monetary policies as stabilization tools and section 5 analyses the interactions between international monetary cooperation and fiscal policies. Section 6 concludes.

2. The model

The world exists for a single period and consists of two equally–sized identical countries, Home and Foreign, both inhabited by a continuum of consumer-producers with monopoly power. Each domestic household has three workers. One of these three workers produces a traded good $Y_D(h)$ to be consumed in the domestic market while the second produces a traded good $Y_E(h)$ to be exported. The third worker produces a non-traded good $Y_N(h)$. Each worker f of a foreign household also produces a non-traded good $Y_{N^*}^*(f)$, a traded good to be consumed in the foreign market $Y_{D^*}^*(f)$, and another traded good to be exported $Y_{E^*}^*(f)$.

2.1. Household preferences

Home household i maximizes the following utility function:

$$U^i = \log C^i - \left[Y_D^i / Z_D + Y_E^i / Z_E + Y_N^i / Z_N \right] + \log \left(M^i / P \right) \tag{1}$$

According to (1), household derives utility from a composite consumption good C^i and from real balances M^i / P where P is the overall price index. The household also bears the

disutility of work effort in sector j measured by Y_j^i/Z_j where j=D, E, N. Implicit to this expression is the assumption that one unit of labor produces Z_j units of output where Z_j is a stochastic variable. An exogenous change in Z_j represents a productivity shock.

The preferences for the foreign representative household are similar.

The composite domestic consumption index C^i is a Cobb-Douglas aggregator over the domestically produced tradable goods C_D^i, imported tradable goods $C_{E^*}^i$ and non-tradable goods C_N^i and is defined as:

$$C^i = (C_D^i)^{\frac{1}{3}}(C_{E^*}^i)^{\frac{1}{3}}(C_N^i)^{\frac{1}{3}} \tag{2a}$$

The sub-indexes in the overall consumption index are CES aggregators over the goods available in each sector and are given as:

$$C_j^i = \left[\int_0^1 C_j^i(h)^{\frac{\theta-1}{\theta}} dh \right]^{\frac{\theta}{\theta-1}}, \quad j\text{=D, N} \quad \text{and} \quad C_{E^*}^i = \left[\int_0^1 C_{E^*}^i(f)^{\frac{\theta-1}{\theta}} df \right]^{\frac{\theta}{\theta-1}} \tag{2b}$$

where $\theta>1$ is the elasticity of substitution between the goods produced within a sector.

The composite foreign consumption index and the corresponding sub-indexes are similar to equations (2a) and (2b).

The overall home and foreign price indexes P and P^* corresponding to the composite aggregate domestic and foreign consumption C and C^* are defined as the minimum expenditure required to purchase one unit of the composite consumption good and are given respectively as follows:

$$P = 3P_D^{\frac{1}{3}}P_{E^*}^{\frac{1}{3}}P_N^{\frac{1}{3}} \quad \text{and} \quad P^* = 3P_{D^*}^{*\frac{1}{3}} P_E^{*\frac{1}{3}} P_{N^*}^{*\frac{1}{3}} \tag{3}$$

In the above expressions, P_D and P_N are the home currency prices of the domestically-consumed tradable and non-tradable goods produced at home while $P_{D^*}^*$ and $P_{N^*}^*$ denote the prices of the foreign tradable and non-tradable goods expressed in the foreign currency. Similarly, P_{E^*} stands for the home currency price of the foreign export good whereas P_E^* represents the foreign currency price of the home traded good exported to the foreign country.

The corresponding sub-indexes of sectoral domestic and foreign prices are given as:

$$P_j = \left[\int_0^1 P_j(h)^{1-\theta} dh \right]^{\frac{1}{1-\theta}} \text{ for } j\text{=D, N, E} \tag{3a}$$

$$P_{j^*}^* = \left[\int_0^1 P_{j^*}^*(f)^{1-\theta} df \right]^{\frac{1}{1-\theta}} \text{ for } j^* = D^*, N^*, E^* \tag{3b}$$

Goods prices are fixed in the currency of the producer. Hence, the home currency price of a foreign traded good exported to the home country $P_{E^*}(f)$ and the foreign currency price of a home traded good exported to the foreign country $P_E^*(h)$ are expressed in the following way where e represents the nominal exchange rate (home currency price of one unit of foreign currency): $P_{E^*}(f) = eP_{E^*}^*(f)$ and $P_E^*(h) = P_E(h)/e$. Since all firms are identical, we have $P_{E^*} = eP_{E^*}^*$ and $P_E^* = P_E/e$ at the sectoral level.

The home household's budget constraint is written as follows:

$$M^i + P_N C_N^i + P_D C_D^i + P_{E^*} C_{E^*}^i + PT = M_0^i + P_D(h)Y_D^i + P_N(h)Y_N^i + P_E(h)Y_E^i \qquad (4)$$

In equation (4), M_0^i and M^i denote the initial and the desired money holdings and T represents lump sum taxes levied by the government.

For simplification purposes we exclude financial markets.

The foreign household's budget constraint is similar to (4)

2.2 Goods demand

Home (foreign) household's demand for a single home (foreign) good h (f) produced in sectors N and D (N^* and D^*), given below, result from the maximization of consumption under the fixed budget constraint:

$$C_j^i(h) = \left[\frac{P_j(h)}{P_j}\right]^{-\theta} C_j \quad \text{and} \quad C_{j^*}^{i^*}(f) = \left[\frac{P_{j^*}^{i^*}(f)}{P_{j^*}}\right]^{-\theta} C_{j^*} \quad \text{for } j=D, N \text{ and } j^* = D^*, N^* \qquad (5a)$$

The foreign (home) demand for a single home (foreign) export good is determined in a similar way and is expressed as follows:

$$C_E^{i^*}(h) = \left[\frac{P_E(h)}{P_E}\right]^{-\theta} C_E^* \quad \text{and} \quad C_{E^*}^i = \left[\frac{P_{E^*}(f)}{P_{E^*}}\right]^{-\theta} C_{E^*} \qquad (5b)$$

We assume that home and foreign governments have the same preferences as private agents but the exported goods sectors in each country are not subject to public demand[1]. This implies that public and private demands have the same form, with $G_j(h)$ and $G_{j^*}^*(h)$ replacing $C_j(h)$ and $C_{j^*}^*(h)$ where $j=D, N$ and $j^* = D^*, N^*$

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[1] Trionfetti (2001) points out to the presence of a government home bias in many of the industrialized countries.

Aggregating public and private demand over each sector gives the following expressions for a single good produced in a sector at home and abroad:

$$Y_j(h) = \left[\frac{P_j(h)}{P_j}\right]^{-\theta} Y_j \text{ and } Y_{j^*}^*(f) = \left[\frac{P_{j^*}^*(f)}{P_{j^*}^*}\right]^{-\theta} Y_{j^*}^* \tag{6}$$

where $Y_j = C_j + G_j$ and $Y_{j^*}^* = C_{j^*} + G_{j^*}$ for $j=D, N$ and $j^* = D^*, N^*$.

Because of the home bias assumption, output equals private consumption in the export good sectors in each country: $Y_E = C_E$ and $Y_{E^*}^* = C_{E^*}$.

2.3 Fiscal authorities

We assume that ricardian equivalence holds and that in each country, the public spending (G, G^*) are financed by taxes (T, T^*) and by seignoriage revenues:

$$G = \frac{M - M_0}{P} + T \text{ and } G^* = \frac{M^* - M_0^*}{P} + T^* \tag{7}$$

Following Corsetti and Pesenti (2001), we define an index of domestic government spending, g, expressed as the ratio of output net of spending to total output: $g = (Y-G)/Y$ while the index of foreign government spending is $g^* = (Y^* - G^*)/Y^*$.

We assume that in each country, the fiscal authority is not interested in discretionary policies, but reacts to an unanticipated productivity shock. Then we have $E(G) = E(G^*)=0$ and $E(g^*) = E(g) = 1$ where E is the expectations operator.

2.4 Household's optimization problem

Home household maximizes his utility given in (1) under the budget constraint (4) taking equation (6) into account. The foreign household solves the same problem. The first order conditions for the three consumptions and the money demand in each country imply the following expressions where we drop the upper indexes i and i^*:

$$PC = 3P_N C_N = 3P_D C_D = 3P_{E^*} C_{E^*} \text{ and } P^*C^* = 3P_{N^*}^* C_{N^*}^* = 3P_{D^*}^* C_{D^*}^* = 3P_E^* C_E^* \tag{8}$$

$$M = PC \text{ and } M^* = P^*C^* \tag{9}$$

Home and foreign representative households derive the following expression from the profit maximization with respect to individual prices under technology and demand constraints (see appendix A) :

$C_j = \frac{\theta-1}{3\theta} Z_j$ and $C_j^* = \frac{\theta-1}{3\theta} Z_j^*$ (10)

where $C_j = Y_j g_j$ and $C_j^* = Y_j^* g_j^*$.

We assume that, when prices are flexible fiscal and monetary authorities are passive implying that $C_j = Y_j$ and $C_j^* = Y_j^*$. The introduction of these equalities into (10) gives the following optimal home and foreign labour supplies :

$$\frac{\hat{Y}_j}{Z_j} = \frac{\theta-1}{3\theta} \text{ and } \frac{\hat{Y}_j^*}{Z_j^*} = \frac{\theta-1}{3\theta}$$ (11a)

where a caret over the variable indicates the flexible price value.

When prices are fixed we have the following expected labor supplies:

$$E\left[\frac{Y_j}{Z_j}\right] = \frac{\theta-1}{3\theta} E\left[\frac{1}{g_j}\right] \text{ and } E\left[\frac{Y_j^*}{Z_j^*}\right] = \frac{\theta-1}{3\theta} E\left[\frac{1}{g_j^*}\right]$$ (11b)

In equations (11), $Eg_j = 1$ in sectors $j = N, D$ and $j^* = N^*, D^*$ and there is no fiscal policy in the exportation sectors.

Comparison of equations (11) shows that expected employment levels are equal to their flexible price values but actual (ex post) employment levels will be determined by sectoral demands and hence by macroeconomic policies.

2.5 Equilibrium

In the present setup current account will always be balanced as pointed out by Corsetti-Pesenti (2001) because of the unit elasticity of substitution between goods produced at home and abroad along with the assumption of no international trade in assets. The following expression gives the home current account balance in terms of domestic currency:

$$P_{E^*} C_{E^*} = P_E C_E^*$$ (12)

Combining this outcome with equations (8) and (9) and remembering that $P_E = e P_E^*$ gives the equilibrium exchange rate as $e = M/M^*$.

Using equations (8) and (9), one can derive output levels and consumption in each sector as follows, remembering that $C_j = Y_j g_j$ and $C_{j^*}^* = Y_{j^*}^* g_{j^*}^*$ for $j=N, D$ and $j^* = N^*, D^*$:

$$Y_j = \frac{M}{3P_j g_j} \text{ for } j=\text{N, D and } Y_{j^*}^* = \frac{M^*}{3P_{j^*}^* g_{j^*}^*} \text{ for } j^* = N^*, D^*$$ (13a)

$$Y_E = \frac{M}{3P_E} \text{ and } Y_{E^*}^* = \frac{M^*}{3P_{E^*}^*} \tag{13b}$$

$$C_j = \frac{M}{3P_j} \text{ for } j\text{=}N, D, E^* \text{ and } C_{j^*}^* = \frac{M^*}{3P_{j^*}^*} \text{ for } j^* = N^*, D^*, E \tag{14}$$

According to (13a) and (13b), an increase in home (foreign) public spending leads to an immediate increase in home (foreign) output of traded and nontraded goods, since output is demand determined when prices are fixed. In contrast, (13b) states that public spending has no effect on the output of exported goods because of the home bias assumption.

Money supply in each country affects output in all three sectors but the effect is not immediate in contrast to public spending. It affects output through its effect on private consumption. Indeed, an increase in the home money supply for a constant level of the foreign money supply determines a depreciation of the home currency. The increase in the exchange rate determines an increase in the price of the foreign imported goods expressed in home currency since $P_{E^*} = eP_{E^*}^*$ where $P_{E^*}^*$ is fixed. The increase in the domestic money supply and the proportional increase in the exchange rate level leave the domestic imported goods consumption C_{E^*} constant according to (14). However, the value of this consumption in home currency $P_{E^*} C_{E^*}$ increases proportionally to M and e.

Since the home consumption of traded and non traded goods increase also proportionally to M with constant prices according to (14), the domestic monetary equilibrium (9) is restored through a higher value of PC and of its components defined in (8).

In the foreign country, the increase in the exchange rate reduces the price of the imported domestic goods expressed in foreign currency as implied by $P_E^* = P_E / e$. This increases the foreign imported goods consumption C_E^* according to (14), but it leaves constant the value of this consumption expressed in foreign currency $P_E^* C_E^*$.

The home trade balance defined in domestic currency remains in equilibrium with greater imports ($P_{E^*} C_{E^*}$) and exports ($P_E C_E^*$).

3. Welfare under fixed and flexible price equilibria

Under fixed prices, expected home welfare can be derived from (1) as follows where we made use of the expected employment level defined from (11b) and of the definition of the

Cobb-Douglas domestic consumption index. As Obstfeld and Rogoff (1995) we assume that the utility from real balances is negligible:

$$E\left[W\right] = \frac{1}{3}\left[Ec_D + Ec_N + Ec_{E^*}\right] - \frac{\theta-1}{\theta} \tag{15}$$

where lower case letters denote log variables.

After some algebra, it is possible to express the fixed-price (expected) home welfare in terms of the flexible-price welfare as follows (see appendix B):

$$E\left[W\right] = E\left[\hat{W}\right] - \tfrac{1}{6}\Lambda \tag{16a}$$

In equation (16a), the expected welfare under flexible prices $E[\hat{W}]$ is defined as follows remembering that $E\left[\hat{y}_j\right] = E\left[\hat{c}_j\right]$:

$$E[\hat{W}] = \tfrac{1}{3}\left[E\hat{y}_D + E\hat{y}_N + E\hat{y}_{E^*}^*\right] - \tfrac{\theta-1}{\theta} \tag{16b}$$

The welfare loss due to price rigidity is expressed as:

$$\Lambda = Var\left[m - g_D - z_D\right] + Var\left[m - g_N - z_N\right] + Var\left[m^* - z_{E^*}\right] \tag{16c}$$

A similar derivation for the foreign country yields $E[W^*] = E[\hat{W}^*] - \tfrac{1}{6}\Lambda^*$.

As implied by (16a) and (16c) and their foreign analogues, policy makers can achieve the flexible price level of welfare if they can eliminate the welfare loss caused by the productivity shock combined with price rigidity.

4. Fiscal and monetary policy as stabilization tools

We would like to assess the efficiency of fiscal and monetary policies as stabilization tools and the possible effect of their interaction on their efficiency. The efficiency is measured as the capacity to reduce or to eliminate the effects of the shocks on expected welfare.

In what follows we will first see the traditional case where all sectors are hit by the same shock in each country. Then we will consider two cases where the shock hits one or two sectors in each country.

Case 1. Identical shocks across all sectors in each country:

$$z_D = z_N = z_E = z > 0\,, z_{D^*} = z_{N^*} = z_{E^*} = z^* > 0\,, Var(z) = \sigma_z^2\,, Var(z^*) = \sigma_{z^*}^2 = k\sigma_z^2\,, k > 0\,.$$

Most of the stochastic NOEM models consider this case where there is only one shock in a country. We assume that the uncertainty on the shocks may be symmetric ($k=1$) or asymmetric ($k \neq 1$) across countries.

We assume that the fiscal and monetary authorities can react to the productivity shocks according following functions:

$$m = \gamma z_j = \gamma z \text{ and } m^* = \gamma^* z_{j^*}^* = \gamma^* z \text{ for } j=D, N, E \text{ and for } j^* = D^*, N^*, E^* \tag{17a}$$

$$g_j = \alpha z_j \text{ and } g_{j^*}^* = \alpha^* z_{j^*}^* \text{ for } j=D, N \text{ and for } j^* = D^*, N^* \tag{17b}$$

where γ and γ^* denote respectively the home and foreign monetary policy reaction coefficients while α and α^* denote the fiscal policy reaction coefficients.

When, for example, labour productivities Z_j and Z_j^* increase in the three sectors of each country, optimally, agents would like to work less for given Y_j and Y_j^* and to consume more, according to equations (10). Then the optimality of labour effort implies an increase in real wages. However, price rigidity prevents such an adjustment in the labour market.

When monetary and fiscal policies are passive (MPFP), welfare losses are given by $\Lambda_{MPFP} = (2+k)\sigma_z^2$ and $\Lambda_{MPFP}^* = (2k+1)\sigma_z^2$ according to equation (16c) and (17) where $\gamma = \gamma^* = 0$ and $\alpha = \alpha^* = 0$. These losses can be reduced or eliminated by active monetary and/or fiscal policy.

When we allow for active monetary and fiscal policies, the welfare loss functions (16c) including (17a) and (17b) take the following form:

$$\Lambda_{MNFN} = Var\left[\gamma - \alpha - 1)z\right] + Var\left[\gamma - \alpha - 1)z\right] + Var\left[\gamma^* - 1)z^*\right] \tag{18a}$$

$$\Lambda_{MNFN}^* = Var\left[\gamma^* - \alpha^* - 1)z^*\right] + Var\left[\gamma^* - \alpha^* - 1)z^*\right] + Var\left[\gamma - 1)z\right] \tag{18b}$$

where MNFN refers to Nash strategy for both fiscal and monetary authorities.

Proposition 1a. *When all sectors in each country are hit by the same shock, monetary policies alone (MNFP) are more efficient with respect to fiscal policies alone (MPFN) regardless of the value of k.*

Proof. When fiscal policies are absent ($\alpha = \alpha^* = 0$), the minimization of (18a) and (18b) over the monetary policy coefficients gives $\gamma = \gamma^* = 1$ which yields $\Lambda_{MNFP} = \Lambda_{MNFP}^* = 0$. When monetary policies are passive ($\alpha = \alpha^* = 0$), the minimization of (18a) and (18b) over the fiscal policy coefficients gives $\alpha = \alpha^* = -1$ which yields $\Lambda_{MPFN} = k\sigma_z^2$ and $\Lambda_{MPFN}^* = \sigma_z^2$. The

comparison of welfare losses under both regimes shows that $\Lambda_{MNFP} < \Lambda_{MPFN}$ and $\Lambda^*_{MNFP} < \Lambda^*_{MPFN}$ for all values of k. ∎

Monetary authorities can reproduce the flexible-price equilibrium when fiscal policies are passive. This result is the same as in Obstfeld and Rogoff (2002) where there is only one shock in both countries. Indeed, an increase in the productivity of home labour reduces the marginal utility of leisure. In this case, labour-leisure trade-off is no longer optimal. Monetary intervention increases private consumption in each country according to equation (14) and restores the optimality of labour-leisure trade-off.

Fiscal policy acts through a different mechanism. Indeed, when monetary authorities are passive, optimal fiscal policy requires increasing the public spending. With fixed prices, private consumption is not crowded out following the fiscal expansion as implied by (14) but the production increases according to equations (13). This in turn, increases the marginal utility of leisure up to the initial level and restores thereby the optimality of labour-leisure trade-off.

Due to the home bias assumption, fiscal authorities react only to shocks that affect the production of sectors N, D, N^* and D^*. By doing this, fiscal authority eliminates the effects of the national shocks in each country, but it cannot react to shocks that affect the production of the exported goods. Hence, when there is a single shock in both countries, fiscal policy alone can not achieve the flexible-price level of welfare in contrast to monetary policy.

Proposition 1b. *When both monetary and fiscal authorities choose to play Nash (MNFN) against identical shocks across all sectors in each country, they are indifferent to any combination of the policy reaction coefficients regardless of the value of k.*

Proof. Minimizing (18a) and (18b) over the policy coefficients yields $\gamma - \alpha = \gamma^* - \alpha^* = 1$. This implies that optimal policy coefficients are indeterminate. Then any combination of the policy coefficients that results from the monetary and fiscal reactions to the shocks ($1 \geq \gamma \geq 0$ and $1 \geq \alpha \geq 0$) and satisfies the condition $\gamma - \alpha = \gamma^* - \alpha^* = 1$ will reduce the welfare losses whatever the value of k: $\Lambda_{MNFN} = (\gamma - 1)^2 k \sigma_z^2 < \Lambda_{MPFP}$ and $\Lambda^*_{MNFN} = (\gamma^* - 1)^2 \sigma_z^2 < \Lambda^*_{MPFP}$ ∎

Whatever the combination of policy coefficients, monetary and fiscal policy are able to eliminate the effects of the shock on nontraded goods and domestically consumed traded goods sectors in the two countries. The effects of the shocks affecting the export goods sector

in the two countries can not be eliminated unless the fiscal authorities optimally decide not to intervene ($\alpha = \alpha^* = 0$ and $\gamma = \gamma^* = 1$).

If the domestic shock has a greater (lower) variance than the foreign implying that $k>1$ ($k<1$) domestic welfare loss will be higher (lower) relative to foreign.

Case 2. Specific shocks in traded goods sectors in each country with no shocks in the nontraded goods sector:

$$z_D = z_E = z > 0, z_{D^*} = z_{E^*} = z^* > 0, z_N = z_{N^*} = 0, Var(z) = \sigma_z^2, Var(z^*) = \sigma_{z^*}^2 = k\sigma_z^2, \ k > 0.$$

Fiscal and monetary authorities can react to the productivity shocks according to the following policy rules:

$$m = \gamma z_j = \gamma z \text{ and } m^* = \gamma^* z_{j^*}^* = \gamma^* z; \text{ with } j=D, E, \text{ and } j^* = D^*, E^* \tag{19a}$$

$$g_D = \alpha z_D = \alpha z \text{ and } g_{D^*}^* = \alpha^* z_{D^*}^* = \alpha^* z^* \tag{19b}$$

Introducing equations (19a) and (19b) in (16c) gives the following welfare losses when both monetary and fiscal policies are active:

$$\Lambda_{MNFN} = Var\left[(\gamma - \alpha - 1)z\right] + Var\left[z\right] + Var\left[(\gamma^* - 1)z^*\right] \tag{20a}$$

$$\Lambda_{MNFN}^* = Var\left[(\gamma^* - \alpha^* - 1)z^*\right] + Var\left[z^*\right] + Var\left[(\gamma - 1)z\right] \tag{20b}$$

When both policies are passive, the productivity shocks yields the following welfare losses:

$$\Lambda_{MPFP} = (1+k)\sigma_z^2 \text{ and } \Lambda_{MPFP}^* = (1+k)\sigma_z^2.$$

Proposition 2a. *When the shock hits only the traded goods sectors in each country, monetary policies alone (MNFP) are more efficient than fiscal policies alone (MPFN) in both countries provided that the uncertainty over home and foreign shocks is similar.*

Proof. Assuming $\alpha = \alpha^* = 0$, minimizing (20a) and (20b) over the monetary policy coefficients gives $\gamma = \gamma^* = \frac{1}{2}$ which yields $\Lambda_{MNFP} = \frac{1}{4}[2+k]\sigma_z^2$ and $\Lambda_{MNFP}^* = \frac{1}{4}[2k+1]\sigma_z^2$. Assuming $\gamma = \gamma^* = 0$, minimizing (20a) and 20b) over α and α^* gives $\alpha = \alpha^* = -1$ which yields $\Lambda_{MPFN} = k\sigma_z^2$ and $\Lambda_{MPFN}^* = \sigma_z^2$.

Monetary policy alone is always more efficient than fiscal policy alone in the home country when $\Lambda_{MNFP} = \frac{1}{4}[2+k]\sigma_z^2 < \Lambda_{MPFN} = k\sigma_z^2$. The same is true for the foreign country when $\Lambda_{MNFP}^* = \frac{1}{4}[2k+1]\sigma_z^2 < \Lambda_{MPFN}^* = \sigma_z^2$. The first condition is met for $k > \frac{2}{3}$ while the second

condition requires $k < \frac{3}{2}$. Then monetary policies alone yield better results in both countries compared to fiscal policies when $\frac{3}{2} > k > \frac{2}{3}$. This condition implies that the uncertainty over home and foreign shocks should not be too asymmetric ∎

Active monetary or fiscal policies are efficient tools of stabilization for any value of k since $\Lambda_{MPFN} < \Lambda_{MPFP}$ and $\Lambda_{MNFP} < \Lambda_{MPFP}$ and $\Lambda^*_{MPFN} < \Lambda^*_{MPFP}$ with $\Lambda^*_{MNFP} < \Lambda^*_{MPFP}$. However, the value of k is important when it comes to comparing monetary policy efficiency to that of fiscal policy. Indeed, because of the home bias, fiscal policy can not stabilize the export goods sector. In contrast, monetary policy can stabilize the export goods sector but it destabilizes the nontraded goods sector. If the shock on the export good sector is sufficiently low, the negative effect of monetary policy on nontraded goods sector dominates the positive effect on export goods sector. In this case fiscal stabilization yields better results because the policy makers accept the loss from unstable export good sector in order to avoid any volatility in nontraded goods sector. For example when $k > \frac{3}{2}$, the shock on home import goods sector is high which implies that home country prefers monetary reaction while foreign country prefers fiscal reaction since the shock in foreign import goods is low.

In contrast to Case 1, monetary policies cannot reproduce the flexible-price equilibrium when fiscal policies are not available. The reason is that, monetary intervention in each country has a negative effect on the nontraded goods sector which is not affected by the shock. To reduce this effect, monetary authorities react less aggressively to shocks, which results in an insufficient level of stabilization in the sectors that are hit by the shock.

Similarly to Case 1, fiscal policy alone in each country cannot achieve the flexible-price equilibrium since fiscal spending has no effect on the imported goods sector because of the home bias assumption. This aspect of home bias is rather worth mentioning because in traditional deterministic models (Frenkel et al. (2002), chapter 2), home bias is rather considered to increase the efficiency of fiscal policy while in this setup it reduces the efficiency of fiscal policy.

Proposition 2b. *When both monetary and fiscal policies are available, monetary authorities in each country optimally choose to stay passive regardless of the value of k assuming that the shock hits only the traded goods sectors in each country.*

Proof. Minimizing (20a) and 20b) over the monetary and fiscal policy coefficients gives $\alpha = \alpha^* = -1$ and $\gamma = \gamma^* = 0$ which yields the following welfare losses: $\Lambda_{MNFN} = k\sigma_z^2$ and $\Lambda_{MNFN}^* = \sigma_z^2$ ∎

In this case, monetary authorities optimally choose to stay passive in both countries. The reason is that money supply affects all sectors equally. This implies that a monetary reaction in one of the countries has a negative effect on the nontraded goods sector which is not affected by the shock. Moreover, monetary policy is unnecessary for the domestically consumed traded goods sector which is already stabilized by the fiscal authority. Finally, home (foreign) monetary intervention affects the foreign (home) export goods sector and not the home (foreign) export sector.

Case3. Specific productivity shocks on nontraded goods sectors of the two countries without any shocks on any other sector:

$$z_D = z_E = z_{D^*} = z_{E^*} = 0, \ z_N > 0, \ z_{N^*} > 0, \ Var(z_N) = \sigma_N^2, \ Var(z_{N^*}) = \sigma_{N^*}^2 = k\sigma_N^2, \ k > 0.$$

In case 3, fiscal and monetary authorities can react to the productivity shocks according the following functions: $m = \gamma z_N$, $m^* = \gamma z_{N^*}$, $g_N = \gamma z_N$ $g_{N^*}^* = \alpha z_{N^*}$.

Introducing these functions in (16c) gives the following welfare losses when both monetary and fiscal policies are active:

$$\Lambda_{MNFN} = Var\left(\gamma z_N\right) + Var\left((\gamma - \alpha - 1)z_N\right) + Var\left[\gamma^* z_{N^*}\right] \tag{21a}$$

$$\Lambda_{MNFN}^* = Var\left[\gamma^* z_{N^*}\right] + Var\left[(\gamma^* - \alpha^* - 1)z_{N^*}\right] + Var\left(\gamma z_N\right) \tag{21b}$$

When monetary and fiscal policy makers do not react to the shocks, welfare decreases in the two countries by the amounts $\Lambda_{MPFP} = \sigma_{z_N}^2$ and $\Lambda_{MPFP}^* = k\sigma_{z_N}$.

Proposition 3. *When there is a shock on the nontraded goods sector in each country, fiscal policy alone can reproduce the flexible-price equilibrium in both countries contrary to monetary policy.*

Proof. Assuming $\gamma = \gamma^* = 0$, minimization of (21a) and (21b) over α and α^* gives the optimal policy fiscal policy coefficients as $\alpha = \alpha^* = -1$ which yields $\Lambda_{MPFN} = \Lambda_{MPFN}^* = 0$.

Assuming $\alpha = \alpha^* = 0$, the minimization of (21a) and (21b) with respect to γ and γ^* yields $\gamma = \gamma^* = \frac{1}{2}$ which implies: $\Lambda_{MNFP} = \frac{2+k}{4}\sigma_{z_N}^2$ and $\Lambda_{MNFP}^* = \frac{1}{2}(k+\frac{1}{2})\sigma_{z_N}^2$ ■

Since there are no shocks in the export goods sector in the foreign country, in contrast to Case 1, fiscal policies are capable of achieving the flexible-price solution when monetary policies are not available. In contrast, monetary policy can not eliminate the welfare loss implying a lower efficiency with respect to fiscal policy.

There are two reasons for the lower efficiency of monetary policies alone. First, the nonseparable character of money supply causes a destabilization in sectors that are not affected by the shocks. Second, the negative spillover effect increases the relative inefficiency of monetary policy. This negative spillover effect comes from the fact that the foreign monetary authority destabilizes the home consumption of imported goods while trying to stabilize foreign consumption of foreign nontraded goods following a shock in this sector.

As in Case 2, monetary authority optimally chooses not to react when fiscal policies are active. Indeed, a monetary intervention in the nontraded goods sector is unnecessary since fiscal intervention has already eliminated the effects of the shock. Moreover, monetary intervention has negative effects on the sectors that are not affected by the shock.

5. International policy cooperation gains

Because of the government home bias assumption, fiscal policies do not react to the shocks on the export goods sectors. Hence they have no role on the stabilization of these sectors according to (16c). In this case, there is no fiscal interdependence between countries and fiscal cooperation is useless. In contrast, uncoordinated monetary policies yield spillover effects which can be internalized by international cooperation.

There are two questions that we will try to answer in this section: first, can cooperative strategy increase the efficiency of monetary policy with respect to the Nash game and second, what are the effects of active fiscal policy on the efficiency of cooperative monetary policy?

As in the previous section we will consider three different cases.

Case 1 : Identical shocks across all sectors in each country :

$$z_D = z_N = z_E = z > 0, \, z_{D^*} = z_{N^*} = z_{E^*} = z^* > 0, Var(z) = \sigma_z^2, \, Var(z^*) = \sigma_{z^*}^2 = k\sigma_z^2, \, k > 0.$$

In what follows, gains from international monetary cooperation will be evaluated with respect to gains from monetary stabilization where monetary authorities choose Nash strategy while fiscal authorities may play Nash game or stay passive.

Proposition 4. *When monetary authorities cooperate internationally against identical productivity shocks across all sectors in each country, there are additional gains from monetary cooperation if fiscal authorities are active. These cooperation gains disappear either when fiscal authorities optimally choose to stay passive or when fiscal policies are not available.*

Proof. When monetary authorities cooperate while fiscal policies adopt a Nash strategy (MCFN), they minimize the following function derived from (18a) and (18b) with respect to γ and γ^* for given fiscal policies:

$$\Lambda_{MCFN} = \frac{1}{2}\left\{ \begin{array}{l} Var\left[(\gamma-\alpha-1)z\right] + Var\left[(\gamma-\alpha-1)z\right] + Var\left[(\gamma^*-1)z\right] \\ + Var\left[(\gamma^*-\alpha^*-1)z\right] + Var\left[(\gamma^*-\alpha^*-1)z\right] + Var\left[(\gamma-1)z\right] \end{array} \right\} \tag{22}$$

The fiscal authority of each country minimizes the following equations for a given monetary policy:

$$\Lambda_{MCFN} = Var\left[(\gamma-\alpha-1)z\right] + Var\left[(-\alpha-1)z\right] + Var\left[(\gamma^*-1)z^*\right] \tag{23a}$$

$$\Lambda^*_{MCFN} = Var\left[(\gamma^*-\alpha^*-1)z^*\right] + Var\left[(^*-\alpha^*-1)z^*\right] + Var\left[(\gamma^*-1)z\right] \tag{23b}$$

Combining the reaction functions resulting from the game above yields $\gamma = \gamma^* = 1$ and $\alpha = \alpha^* = 0$ which implies $\Lambda_{MCFN} = \Lambda^*_{MCFN} = 0$. Comparing this result to the welfare loss under MNFN game shows that $\Lambda_{MNFN} = \Lambda^*_{MNFN} \succ \Lambda_{MCFN} = \Lambda^*_{MCFN}$ when fiscal authorities are active in the Nash game implying that $\alpha = \alpha^* \neq 0$ and $\gamma = \gamma^* \neq 1$. However, when $\alpha = \alpha^* = 0$ and $\gamma = \gamma^* = 1$ implying that fiscal authority optimally chooses to stay passive under Nash game, we have $\Lambda_{MNFN} = \Lambda^*_{MNFN} = \Lambda_{MCFN} = \Lambda^*_{MCFN} = 0$. Moreover, when monetary authorities cooperate while fiscal policies are not available ($\alpha = \alpha^* = 0$), they minimize (22) with respect to γ and γ^*. This gives $\gamma = \gamma^* = 1$ implying that $\Lambda_{MCFP} = \Lambda^*_{MCFP} = \Lambda_{MNFP} = \Lambda^*_{MNFP} = 0$ ∎

Monetary cooperation yields no additional gains with respect to monetary stabilization gains when fiscal policies are not available. The reason is that as in Obstfeld and Rogoff (2002), international risk sharing is perfect since home (foreign) monetary authority fully stabilizes the foreign (home) consumption of home (foreign) goods. Then monetary

authorities can aim at reproducing the flexible-price equilibrium both under Nash and cooperative games. Moreover, as in Lombardo-Sutherland (2004), fiscal policies have no impact on monetary policy efficiency in a cooperative equilibrium since $\Lambda_{MCFN} = \Lambda_{MCFP}$ and $\Lambda^*_{MCFN} = \Lambda^*_{MCFP}$.

Case 2: Specific shocks in traded goods sectors in each country with no shocks in the nontraded goods sector:

$$z_D = z_E = z > 0, z_{D^*} = z_{E^*} = z^* > 0, z_N = z_{N^*} = 0, Var(z) = \sigma_z^2, Var(z^*) = \sigma_{z^*}^2 = k\sigma_z^2, \ k > 0.$$

When there is no uncertainty on the productivity level in one of the sectors, in contrast to Case 1, monetary policy faces a trade-off between sectors. Moreover, cooperative strategy allows monetary authorities to internalize the spillover effects that result from home (foreign) monetary reaction on foreign (home) consumption of home (foreign) goods. This implies the possibility of additional gains from international monetary cooperation.

Proposition 5a. *When fiscal policy is not available, both countries gain from monetary cooperation against productivity shocks in traded goods sectors provided that the uncertainty on the shocks are not too asymmetric across countries.*

Proof. When monetary authorities internationally cooperate while fiscal policies are not available (MCFP), they minimize the following loss function with respect to γ and γ^* given the monetary rules defined in (19a):

$$\Lambda_{MCFP} = \frac{1}{2}\left\{ \begin{array}{l} Var\left[(\gamma - 1)z\right] + Var\left[z\right] + Var\left[\gamma^* - z^*\right] \\ + Var\left[(\gamma^* - 1)z^*\right] + Var\left[\gamma^* z^*\right] + Var\left[\gamma - z\right] \end{array} \right\} \tag{24}$$

The resulting home and foreign policy reaction coefficients are $\gamma = \gamma^* = 2/3$ which yield:

$$\Lambda_{MCFP} = \tfrac{1}{9}(5 + k)\sigma_z^2 \text{ and } \Lambda^*_{MCFP} = \tfrac{1}{9}(5k + 1)\sigma_z^2.$$

The gains from monetary cooperation with respect to the monetary Nash strategy are given by:

$$\Lambda_{MNFP} - \Lambda_{MCFP} = (\tfrac{1}{2} + \tfrac{1}{4}k)\sigma_z^2 - (\tfrac{5}{9} + \tfrac{1}{9}k)\sigma_z^2 = \tfrac{5k-2}{36} > 0 \text{ when } k > \tfrac{2}{5}$$

$$\Lambda^*_{MNFP} - \Lambda^*_{MCFP} = (\tfrac{1}{2}k + \tfrac{1}{4})\sigma_z^2 - (\tfrac{5}{9}k + \tfrac{1}{9})\sigma_z^2 = \tfrac{5-2k}{36} > 0 \text{ when } k < \tfrac{5}{2}$$

The above equations show that there are cooperation gains from monetary policy alone for both countries when $\tfrac{5}{2} > k > \tfrac{2}{5}$.

When the variance of the home shock is relatively large with respect to the variance of the foreign shock ($k<\frac{2}{5}$), cooperative monetary policy is beneficial only to the foreign country. When $k > \frac{5}{2}$, only the home country benefits from monetary cooperation. ∎

In the cooperative case, monetary authorities internalize the positive externalities concerning the import goods sector in each country. Hence, monetary reaction is more aggressive under cooperation with respect to Nash response. This, in turn, leads to a higher stabilization of the domestically consumed traded goods sectors with respect to the Nash strategy. The positive effect of higher stabilization on welfare is higher than the negative effect of the destabilization of nontradable goods sectors in both countries as long as $\frac{5}{2}>k>\frac{2}{5}$.

Proposition 5b. *Active fiscal policy in each country may enhance the efficiency of international monetary cooperation depending on the value of k.*

Proof. When monetary authorities internationally cooperate while fiscal authorities choose a Nash strategy (MCFN), they minimize the following loss function with respect to γ and γ^* taking the fiscal strategy as given :

$$\Lambda_{MCFN} = \frac{1}{2}\left\{ \begin{array}{l} Var\left[(\gamma-\alpha-1)z\right]+Var\left[z\right]+Var\left[(\gamma^*-1)z^*\right] \\ +Var\left[(\gamma^*-\alpha^*-1)z^*\right]+Var\left[z^*\right]+Var\left[(\gamma-1)z\right] \end{array} \right\} \tag{25}$$

Fiscal authorities in each country minimize the following welfare losses with respect to α and α^* taking the reaction of monetary authorities as given :

$$\Lambda_{MCFN} = Var\left[(\gamma-\alpha-1)z\right]+Var\left[z\right]+Var\left[(\gamma^*-1)z^*\right] \tag{26a}$$

$$\Lambda^*_{MCFN} = Var\left[(\gamma^*-\alpha^*-1)z^*\right]+Var\left[z^*\right]+Var\left[(\gamma-1)z\right] \tag{26b}$$

Combining the reaction functions resulting from the game above yields $\alpha = \alpha^* = -\frac{1}{2}$, $\gamma = \gamma^* = \frac{1}{2}$. Then we have $\Lambda_{MCFN} = \frac{1}{4}\sigma_z^2(1+k)$ and $\Lambda^*_{MCFN} = \frac{1}{4}\sigma_z^2(1+k)$.

The gains generated by international monetary cooperation when fiscal authorities play Nash relative to the gains from monetary and fiscal Nash strategies is given by:

$$\Lambda_{MCFP} - \Lambda_{MCFN} = \frac{11-5k}{36}\sigma_z^2 >0 \text{ when } k < \frac{11}{5}$$

$$\Lambda^*_{MCFP} - \Lambda^*_{MCFN} = \frac{11k-5}{36}\sigma_z^2 >0 \text{ when } k > \frac{5}{11}$$

According to these equations, monetary cooperation yields a higher welfare loss with passive than with active fiscal policies in both countries when $\frac{11}{5} > k > \frac{5}{11}$.∎

The previous section showed that monetary authorities choose to stay passive when fiscal authorities are active under the Nash game. In contrast, under cooperation they are induced to react to shocks since there are gains to exploit. The reason is that, although monetary reaction without fiscal intervention does not eliminate the effects of the shock on domestically consumed traded goods sector, it leads to a higher response compared to the case when fiscal policy plays Nash. Indeed, the home and foreign monetary reaction coefficients are equal to $\frac{2}{3}$ when fiscal policy is not available instead of $\frac{1}{2}$ when fiscal authority is active. This implies that the negative effects of the monetary reaction on the nontraded goods sector are higher in the former case. On the other hand, the positive effect on the export goods sector is also higher. The negative effect dominates the positive effect depending on the values of k and cooperative monetary policy leads to a higher welfare loss when fiscal policy is absent.

When fiscal policy is absent, either home or foreign monetary authority looses from cooperation if the uncertainty on shocks is too asymmetric across countries ($k < \frac{1}{3}$ or $k > 3$). The reason is that, the gains from the internalization of the positive externalities are too small with respect to the cost of the destabilization of non traded goods sectors.

Case 3. Identical shocks in nontraded goods sector without any shocks on any other sector.
$z_N = z > 0, z_{N^*} = z^* > 0, z_D = z_E = z_{D^*} = z_{E^*} = 0, Var(z) = \sigma_z^2, Var(z^*) = \sigma_{z^*}^2 = k\sigma_z^2, \ k > 0$.

Section 4 already showed that under Case 3, fiscal policy alone is capable of reproducing the flexible-price level of welfare in both countries. Hence, monetary authorities choose optimally to stay passive whenever fiscal policy is available. Since fiscal Nash regime achieves the flexible-price level of welfare fiscal authorities expect no additional gains from international cooperation. In contrast, there may be gains from monetary cooperation when fiscal policies are not available.

Proposition 6. *In the absence of fiscal policy, both countries gain from international monetary cooperation against productivity shocks in nontraded goods provided that the uncertainty over shocks is not too asymmetric across countries.*

Proof. When monetary authorities choose to cooperate while fiscal policy is not available, they minimize the following expression over their own monetary policy coefficients:

$$\Lambda_{MCFP} = \frac{1}{2} \left\{ \begin{array}{l} Var[(\gamma - 1)z_N] + Var[\gamma z_N] + Var[\gamma^* z_{N^*}] \\ + Var[(\gamma^* - 1)z_{N^*}] + Var[\gamma^* z_{N^*}] + Var[\gamma z_N] \end{array} \right\} \tag{27}$$

which yields $\gamma = \gamma^* = 1/3$. This implies that $\Lambda_{MCFP} = \frac{1}{9}(5+k)\sigma_{z_N}^2$ and $\Lambda_{MCFP}^* = \frac{1}{9}(5k+1)\sigma_{z_N}^2$.

The gains generated by monetary cooperation with respect to the monetary Nash strategy are given by:

$$\Lambda_{MNFP} - \Lambda_{MCFP} = \frac{1}{2}(1 + \frac{k}{2})\sigma_z^2 - \frac{1}{9}(5+k)\sigma_{z_N}^2 = 5k - 2 > 0 \text{ when } k > \frac{2}{5}$$

$$\Lambda_{MNFP}^* - \Lambda_{MCFP}^* = \frac{1}{2}(k + \frac{1}{2})\sigma_{z_N}^2 - \frac{1}{9}(5k+1)\sigma_{z_N}^2 = 5 - 2k > 0 \text{ when } k < \frac{5}{2}$$

Monetary cooperation is beneficial for both countries if $\frac{2}{5} < k < \frac{5}{2}$. ∎

When $\frac{2}{5} < k < \frac{5}{2}$, monetary cooperation induces both monetary authorities to internalize their negative effect on the export goods sector of the other country and thereby to reduce their reactions. The reaction coefficients γ and γ^* are equal to 1/3 under cooperation instead of 1/2 under Nash. This implies that the positive effect of monetary policy on nontraded goods sector is lower under cooperation relative to the Nash game. On the other hand, the negative effects on the other sectors are also lower. The second effect dominates the first one and monetary cooperation yields a lower welfare loss compared to the monetary Nash game. However, these gains disappear when fiscal authority becomes active.

When $k > \frac{5}{2}$ or $k < \frac{2}{5}$, either the home or the foreign country benefits from monetary cooperation unilaterally

6. Conclusion

The present paper offers a static stochastic model of NOEM with three production sectors in order to analyze monetary and fiscal policy efficiency against productivity shocks as well as to analyze international policy cooperation. The setup allows also to consider the impact of monetary policy on fiscal policy efficiency and vice-versa.

The assumption of three production sectors allows for a possibility of different shocks in different sectors. This implies that when some of the sectors are hit by a shock while others are not affected, monetary authority in each country faces a trade-off between stabilizing the sectors that are hit and destabilizing the sectors that are not affected by the shock. Contrary to the monetary authority, fiscal authorities do not face such a trade-off since they can intervene

separately in each sector. However, they suffer from an instrument insufficiency because they can not affect the consumption of exported goods due to the home bias assumption.

We begin with the case where all sectors are hit by the same shock, which corresponds to the case studied in Obstfeld and Rogoff (2002) or Lombardo and Sutherland (2004). Then we consider two other cases in each of which the shock affects some of the sectors while other sectors are not affected. We also allow for an internationally asymmetric structure regarding the variance of the shocks.

The results show that, in contrast to case 1, monetary policy alone can not reproduce the flexible-price equilibrium under cases 2 and 3. Furthermore, active fiscal policy reduces monetary policy efficiency under case 1 whereas the latter chooses optimally to stay passive under cases 2 and 3. Finally, monetary policy alone is more efficient with respect to fiscal policy alone under cases 1 and 2, while fiscal policy alone proves to be more efficient than monetary policy alone under case 3.

When the uncertainty over shocks is not too asymmetric across countries, both countries gain from international monetary cooperation. Active fiscal policy increases the gains from monetary cooperation under case 2. However, under case 3, there are gains from monetary cooperation only when fiscal policy is passive. When the uncertainty over shocks is highly asymmetric across countries, monetary cooperation is counter-productive either for the home or for the foreign country and Nash strategy yields better results.

The model does not allow for the analysis of international fiscal policy cooperation because of the international fiscal interdependence structure. Indeed, the assumption of home bias in public spending prevents any interaction between home and foreign fiscal authority. However, the assumption of home bias is necessary in order to create an interaction between monetary and fiscal authorities. Indeed, there would probably be no need for monetary policy if fiscal authorities could intervene in all sectors in the same way. Nevertheless, it may be possible to create a link between fiscal authorities in each country while keeping the assumption of home bias in public spending. One possible way of doing this would be to assume that fiscal authorities can impose a distortionary tax on the output of exported goods in each country. In such a setup, fiscal authority of one country would be able to adjust its production of export goods by the amount required to stabilize the consumption of the other country, which would give rise to possible cooperation gains.

Appendix A. Expected level of labour supply

The pricing decision of the representative domestic household producing good $j=N,D$ results from the maximization of its profits under the demand and technology constraints:

$$\max_{P_j(h)} P_j(h)Y_j(h) - \kappa L_j(h)$$

$$\text{s.t. } Y_j(h) = Y_j^d(h) \text{ and } Y_j(h) = Z_j L_j(h) \tag{A.1}$$

where $Y_j^d(h)$ is given by equations (6) and κ is the shadow price of labour in an economy where each agent is consumer-producer. This price is measured by $\kappa = 1/\lambda$ where λ is the Lagrange multiplier associated to the individual budget constraint. Technically, λ results from the maximization of utility (1) under the budget constraint (4) taking equation (6) into account. The resulting λ measures the marginal consumption utility of the three goods:

$$\lambda = \frac{1}{3C_N P_N} = \frac{1}{3C_D P_D} = \frac{1}{3C_{E^*} P_{E^*}} = \frac{1}{CP} \tag{A.2}$$

Solving the problem given in A.1 making use of A.2 yields equation (10) for domestic country in the text: $C_j = \frac{\theta-1}{3\theta} Z_j$. Introducing $C_j = Y_j g_j$ in equation (10) gives the optimal domestic labour supply.

Appendix B. Expected home welfare

Taking the log of home expected labor supply when prices are flexible (11a) and fixed (11b) assuming that all the variables are lognormally distributed, we get:

$$\hat{y}_j = z_j + \log \tfrac{\theta-1}{3\theta} \tag{B.1}$$

$$\log E\left[Y_j / Z_j\right] = E\left[y_j - z_j\right] + \tfrac{1}{2} Var\left[y_j - z_j\right] = \log \tfrac{\theta-1}{3\theta} \tag{B.2}$$

Putting equation (B.1) into the expectations operator and remembering that $E\left[z_j\right] = 0$ yields $E\left[\hat{y}_j\right] = \log \tfrac{\theta-1}{3\theta}$. Combining this expression with equation (B.2) gives:

$$Ey_j = E\hat{y}_j - \tfrac{1}{2} Var\left[y_j - z_j\right] \tag{B.3}$$

In order to create a link between output and consumption in equation (15), we take the expectations of the log of $C_j = Y_j g_j$. Then using equations (13a) and (13b), we get:

$$Ec_j = E\hat{y}_j - \frac{1}{2} Var[m - g_j - z_j]; \quad j=N, D \tag{B.4}$$

$$Ec_{E^*} = E\hat{y}^*_{E^*} - \frac{1}{2}Var[m^* - z_{E^*}]$$ (B.5)

Introducing equations (B.4) and (B.5) into equation (15) gives the expression for the expected home welfare as follows:

$$E\left(W\right) = \tfrac{1}{3}\left(E\hat{y}_D + E\hat{y}_N + E\hat{y}^*_{E^*}\right) - \tfrac{\theta-1}{\theta} - \tfrac{1}{6}\left(Var\left(m - g_D - z_D\right) + Var\left(m - g_N - z_N\right) + Var\left[m^* - z_{E^*}\right]\right)$$ (B.6)

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