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ABSTRACT

In the last decade the analysis of open economy macroeconomics shifted from a static framework to an intertemporal one. Simultaneously, macroeconomic models have increasingly incorporated imperfectly competitive structures in order to by-pass the limitations of the walrasian framework.

Our model combines both features following the Obstfeld and Rogoff (1995) and Sutherland (1996) papers. However, instead of considering monopolistically competitive markets as in the Dixit and Stiglitz (1977) and Blanchard and Kiyotaki (1987) tradition, we assume size to be an important issue both at the industry and at the economy level as in d'Aspremont et al. (1989).

Fiscal policy is shown to be effective on the aggregate output level, both in the short and the long runs. Nevertheless, its effect on welfare is ambiguous and a numerical simulation experiment shows a walrasian feature of the model: fiscal expansion may decrease welfare.

Allowing for free entry in the long run intensifies the positive effect on aggregate output and lessens the negative effect on welfare. In fact, with free entry it is possible to reach a new steady state which Pareto dominates the initial one.

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FISCAL POLICY IN A SMALL OPEN ECONOMY WITH COURNOT COMPETITION IN THE NON-TRADABLE GOOD SECTOR*

By Luís F. Costa**

In this article we develop an intertemporal general equilibrium two-sector model for a small open economy. Firms in the non-tradable good sector are assumed to be large, both at the industry and the economy levels, and to compete over quantities. The exchange rate is fixed and financial capital is perfectly mobile. We study the effects of government purchases of goods on the macroeconomic short-run and long-run equilibria when free entry is possible in the steady state. Sufficient conditions for welfare improvement are also derived.

1. INTRODUCTION

IN THE LAST DECADE the analysis of open economy macroeconomics shifted from a static framework to an intertemporal one. Simultaneously, macroeconomic models have increasingly incorporated imperfectly competitive structures in order to by-pass the limitations of the walrasian framework. These two features, however, remained separate in international macromodels until recently [for examples, see inter alia Backus et al. (1994); Dixon (1994)]. Even for closed economies, dynamic general equilibrium models of imperfect competition are a recent field of research [see inter alia Hairault and Portier (1993); Rotemberg and Woodford (1995)].

Our model combines both features following the Obstfeld and Rogoff (1995) and Sutherland (1996) papers. We consider the division of the domestic economy in two sectors: one producing a tradable and the other one a non-tradable good. Since the economy is small in the international market for the tradable good, perfect competition holds in its domestic market. The non-tradable good market is assumed to be imperfectly competitive. However, instead of considering monopolistically competitive markets as in the Dixit and Stiglitz (1977) and Blanchard and Kiyotaki (1987) tradition, we assume size to be an important issue both at the industry and at the economy level as in d'Aspremont et al. (1989). In addition, exchange rate is assumed to be fixed, financial capital to be perfectly mobile and labour markets to be perfectly competitive.

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In section 2 we derive the microeconomic behaviour for every agent in the domestic economy. The outcomes are put together at the macroeconomic level, in section 3, to generate a benchmark initial steady state and a comparative static approach is used to investigate the effects of small deviations from the initial conditions. We develop a dynamic log-linearised model in section 4 and look, in particular, to the short-run effects of a small increase in government purchases of goods. In section 5 we study the long-run effects of fiscal policy, both temporary and permanent shocks, allowing new firms to entry the non-tradable good market. Finally, in section 6, we assess fiscal policy from the point of view of household's intertemporal utility.

Fiscal policy is shown to be effective on the aggregate output level, both in the short and the long runs. Allowing for free entry in the long run intensifies the positive effect on aggregate output and lessens the negative effect on welfare. In fact, with free entry it is possible to reach a new steady state which Pareto dominates the initial one. In an economy with a sufficiently high level of imperfect competition, fiscal policy can be used to decrease market power and to improve the household's intertemporal utility.

Nevertheless, the effect of fiscal policy on welfare is ambiguous and a numerical simulation experiment shows a walrasian feature of the model: fiscal expansion may decrease welfare. We show that, in the absence of free entry, the mark-up in the non-tradable good sector is not affected by fiscal policy and, therefore, the walrasian effect always holds.

2. MICROECONOMIC FOUNDATIONS

There are two goods produced: a tradable and a non-tradable good. We assume a small open economy, so that the price of the tradable good is set in the international market and is exogenous. In both sectors, firms use labour as the only input to produce output. Labour is sector specific and we will refer to each type as 'tradable' and 'non-tradable' labour. Both labour markets are perfectly competitive. Government expenditure is pure waste: it affects neither household utility or the firms' productivity, and it is made on a basket of both types of goods. This agent uses a lump-sum tax to finance its expenditure. Domestic agents can hold their savings under two different forms: domestic currency and an international bond. The exchange rate is permanently fixed, i.e. it follows a flat and shock-free path over time, and we normalise it to unity. Financial capital is perfectly mobile and labour is internationally immobile. All quantities are expressed in per capita terms.

2.1. Household behaviour

There is a representative household maximizing an additive intertemporal utility function over an infinite lifetime horizon

$$(1.)\qquad \max_{C_t,\, N_t^T,\, N_t^{NT},\, M_t/P_t} \sum_{t=0}^{+\infty} \beta^t . \left\{ \frac{C_t^\gamma}{\gamma} - \frac{\xi}{\mu} . \left[\left(N_t^T\right)^\mu + \left(N_t^{NT}\right)^\mu \right] + \frac{\chi}{1-\varepsilon} . \left(\frac{M_t}{P_t} \right)^{1-\varepsilon} \right\}$$

where $0 < \beta < 1$ is the discount factor, C_t is an aggregate consumption index, N_t^T the quantity of 'tradable' labour supplied, N_t^{NT} the quantity of labour used in the non-tradable good sector[1] and M_t / P_t the real money balances. Also we suppose $\varepsilon > 0$, $\gamma \leq 1$, χ, $\xi \geq 0$, and $\mu > 1$.

The sub-utility function C_t is Cobb-Douglas and homogeneous of degree one (HoDO)

$$(2.)\qquad C_t \equiv u\left(C_t^T, C_t^{NT}\right) = \left(C_t^T\right)^\alpha . \left(C_t^{NT}\right)^{1-\alpha}$$

where C_t^T is the consumption of tradable good and C_t^{NT} the consumption of non-tradable good, and C_t can be defined as the aggregate consumption index.

The budget constraint is given by

$$(3.)\qquad \begin{aligned} &\left(1+i_{t-1}\right). P_{t-1}. F_{t-1} + M_{t-1} + w_t^T . N_t^T + w_t^{NT} . N_t^{NT} + \Pi_t = \\ &= P_t . F_t + M_t + p_t^T . C_t^T + p_t^{NT} . C_t^{NT} + P_t . \tau_t^h \end{aligned}$$

where F_t is the real net foreign asset holdings of this household at the end of period t,[2] M_t the domestic currency holdings,[3] i_t is the world nominal interest rate paid on bonds held until the end of period t, w_t^s ($s = T, NT$) is the wage rate for type s labour, Π_t is the profit income, p_t^T the price for the tradable good, p_t^{NT} the price for the non-tradable good, and τ_t^h is the real amount of tax paid by this household.

The cost of living index compatible with the consumption sub-utility function we presented has the following form

$$(4.)\qquad P_t = \iota . \left(p_t^T\right)^\alpha . \left(p_t^{NT}\right)^{1-\alpha}$$

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[1] This type of household utility function may arise from a centralized decision household with two differently skilled individuals. Notice both types of labour are imperfect substitutes and its elasticity of substitution is 1/(1-μ).

[2] All stocks are measured at the end of the period denoted.

[3] We assume the household cannot hold foreign currency.

where the parameter ι is a function of α given by $\iota = \alpha^{-\alpha}.(1-\alpha)^{-(1-\alpha)}$.

We assume all profits to be distributed to the household. Total profit income is

(5.) $$\Pi_t = \Pi_t^T + \sum_{i=1}^{m} \Pi_{i,t}^{NT}$$

where Π_t^T is the profit of the representative firm producing the tradable good and $\Pi_{i,t}^{NT}$ (i = 1, ..., m) the profit of firm i, a producer of the non-tradable good.

The household is a price taker in both labour markets. The two types of labour have the same production costs and give the household the same disutility. The household is also a price taker in goods and financial markets. Furthermore, we assume the household to have no influence on firms' decisions. Therefore, profit levels are taken as given.

Now, we can derive the first order conditions to the household's intertemporal optimisation problem as follow

(H.1.) $$C_{t+1} = \left[\frac{P_t}{P_{t+1}}.\beta.(1+i_t)\right]^{\frac{1}{1-\gamma}}.C_t$$

(H.2.) $$C_t^T = \alpha.\left(\frac{p_t^T}{P_t}\right)^{-1}.C_t$$

(H.3.) $$C_t^{NT} = (1-\alpha).\left(\frac{p_t^{NT}}{P_t}\right)^{-1}.C_t$$

(H.4.) a,b $$\xi.\left(N_t^s\right)^{\mu-1} = \left(C_t\right)^{\gamma-1}.\frac{w_t^s}{P_t}$$ (s = T, NT)

(H.5.) $$\chi.\left(\frac{M_t}{P_t}\right)^{-\varepsilon}.\left(C_t\right)^{1-\gamma} = \frac{i_t}{1+i_t}$$

Equation (H.1.) is the Euler equation for the aggregate consumption index. Equations (H.2.) and (H.3.) give us the demand functions for both goods. Equations (H.4.) give us the household's supplies for both types of labour, where the left-hand sides represent marginal disutilities of labour and the right-hand sides represent marginal utilities of real wages. Equation (H.5.) represents the real balances demand behaviour: the marginal utility of money balances has to be equal to the opportunity cost measured in terms of aggregate consumption.

This set of equations is very similar those we can find in both Obstfeld and Rogoff (1995) and Sutherland (1996). The differences between this household and the one presented in the Obstfeld and Rogoff (1995) model with nontraded goods,[4] are due to the small open economy assumption, different sub-utility functions considered for consumption goods and to the existence of two different types of labour.

2.2. The tradable good sector

Aggregating over all the firms in the sector, we consider a representative firm maximizing its present discounted value of real profits

(6.) $$\max_{q_t^T} \sum_{t=0}^{+\infty} a_t^T . \pi_t^T$$

where a_t^T stands for the firm's discount factor and π_t^T for its flow of real profits.

Let us first define the discount factor to the representative firm in this sector[5]

(7.) $$a_t^T = a_t = \prod_{s=0}^{t} \frac{1}{1+r_s} \text{ for } t \geq 1, \text{ and } a_0 = 1$$

where r_s is the real interest rate at period s, which can be derived using the *Fisher* equation

(8.) $$(1+i_t) = \frac{P_{t+1}}{P_t}.(1+r_t)$$

By definition, the flow of real profits is given by

(9.) a,b,c $$\pi_t^T = RTR_t^T - RTC_t^T \qquad RTR_t^T = \frac{p_t^T . q_t^T}{P_t} \qquad RTC_t^T = \frac{w_t^T . N_t^T}{P_t}$$

where RTR_t^T is its real total revenue in period t, RTC_t^T its real total costs and q_t^T is the domestic production of the tradable good.

Also, we assume a Cobb-Douglas production function with non-increasing returns to scale

(10.) $$q_t^T = 1.\left(N_t^T\right)^{\phi}$$

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[4] Op. cit. appendix pp. 655-658.

[5] We will assume the same discount factor in the non-tradable sector.

where $0 < \phi \leq 1$.

Finally, the firm uses a type of labour which is traded in a perfectly competitive market, therefore it also acts there as a price taker.

Considering the above equations, the firm's optimization problem is a static one, and the first order conditions are given by

(T.1.) $$p_t^T = \frac{w_t^T}{\phi}.\left(q_t^T\right)^{\frac{1-\phi}{\phi}}$$

(T.2.) $$\frac{w_t^T}{p_t^T} = \phi.\left(N_t^T\right)^{\phi-1}$$

Equation (T.1.) represents the supply of tradable good by the domestic sector. It equates the good's price and its marginal cost of production. In equation (T.2.) we have the standard optimal condition in the 'tradable' labour market, i.e. the own product real wage rate has to equal the marginal product of labour. In other words, this is the representative firm's demand for 'tradable' labour.

2.3. The government

We assume the government to have the same preferences as the household, so it purchases a composite good of both individual goods given by $G_t = (G_t^T)^{\alpha}.(G_t^{NT})^{1-\alpha}$. Since the quantities of both goods consumed by the government do not affect nor the utility level of the household or the production functions of the firms, this consumption can be seen as pure waste, despite the view of the government.

Total taxes are lump-sum in real terms (i.e. in terms of the composite consumption good), and they correspond to

(11.) $$\tau_t = \tau_t^h + \sum_{i=1}^{m} \tau_t^{NT}$$

where τ_t^{NT} is a lump-sum tax paid by each firm in the non-tradable good sector.

Considering we have a single infinitely living household, ricardian equivalence holds in this model. Therefore, not much is lost if we ignore borrowing, through the international bond, in the government budget constraint. Assuming there is an independent central bank which is responsible for keeping the exchange rate level, the government budget constraint is given by the following expression

(12.) $P_t.\tau_t = p_t^T.G_t^T + p_t^{NT}.G_t^{NT}$[6]

where G_t^T stands for government purchases of tradable good and G_t^{NT} for its purchases of non-tradable good.

Consequently, government demand functions are given by

(G.1.) $$G_t^T = \alpha.\left(\frac{p_t^T}{P_t}\right)^{-1}.G_t$$

(G.2.) $$G_t^{NT} = (1-\alpha).\left(\frac{p_t^{NT}}{P_t}\right)^{-1}.G_t$$

Both demand functions are similar to those we derived from the household's optimisation program. This fact is due to the identical preferences assumed.

2.4. The non-tradable good sector

Let us analyse the behaviour of firm i (i = 1, ..., m) in this sector. As the representative firm in the tradable sector, each one of these firms maximizes its present discounted value of real profits

(13.) $$\max_{q_{i,t}} \sum_{t=0}^{+\infty} a_{i,t}.\pi_{i,t}^{NT} \qquad (i = 1, ..., m)$$

We consider the discount factor for each firm in the non-tradable good sector to be same as in the tradable good sector ($a_{i,t} = a_t$, i = 1, ..., m). Also, we assume the firms to take the real interest rate as given.

By definition, the flow of real profits is given by

(14.) $$\pi_{i,t}^{NT} = \frac{p_t^{NT}.q_{i,t}^{NT}}{P_t} - \frac{w_t^{NT}.N_{i,t}^{NT}}{P_t} - \tau_t^{NT} \qquad (i = 1, ..., m)$$

where $q_{i,t}^{NT}$ stands for its production of non-tradable good, $N_{i,t}^{NT}$ is the quantity of labour it uses and τ_t^{NT} is the real amount of profit taxes paid by this firm.[7]

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[6] We assume the Central Bank has a commitment to always hold the same level of foreign currency. This assumption implies international payments are done through the capital account and not through money flows. The introduction of international money flows would give rise to a much more complex model which would distract us from our initial goals.

[7] We can find the same idea in Snower (1983). This will introduce a fixed cost necessary in order to get a finite number of firms with free entry. An alternative approach could have been to introduce fixed costs via technology as in Blanchard and Kiyotaki (1987), Dixon and Lawler (1996) or Heijdra

We suppose labour to be the only input in this sector and every firm to use a constant returns to scale technology

$$q_{i,t}^{NT} = 1.\, N_{i,t}^{NT} \qquad (i = 1, ..., m) \tag{15.}$$

In this case, each firm has to consider its own effect on the market price for the non-tradable good since we are in an oligopoly situation. Therefore, we have to take into account the market objective demand function for the non-tradable good. According to the household and government behaviour, this function is given by

$$D_t^{NT} = (1-\alpha).\left(\frac{p_t^{NT}}{P_t}\right)^{-1}.D_t \tag{16.}$$

where $D_t^{NT} = C_t^{NT} + G_t^{NT}$ is the total demand for non-tradable good and $D_t = C_t + G_t$ is the total domestic demand for both goods, expressed in composite good units.

Also, we know from both demand functions that, due to identical preferences, we have an additional condition

$$\frac{C_t^{NT}}{C_t} = \frac{G_t^{NT}}{G_t} \tag{17.}$$

The market clearing condition is, as usual, given by

$$D_t^{NT} = \sum_{i=1}^{m} q_{i,t}^{NT} \tag{18.}$$

Following the Dixit and Stiglitz (1977) and Blanchard and Kiyotaki (1987) monopolistically competitive framework, as in Obstfeld and Rogoff (1995) and Sutherland (1996), every firm is too small to consider its own effects in the aggregate level. Following the Hart (1982) approach, as in Rivera-Campos (1992) and Santoni (1996) the industry itself is too small when compared with the entire economy; this is what d'Aspremont et al. (1997) defined as Cournotian Monopolistic Competition. Here, we introduce a new assumption: let every each firm in the non-tradable sector be big enough to consider the feedback effects of its own actions on the aggregate price

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and van der Ploeg (1996). However, since we are dealing with a fixed cost measured in terms of composite good, the aggregate price index would enter the production function when we assume the firm to be large in the economy. Another way of introducing fixed costs could be based on the firm's need for working capital, i.e. an overhead quantity of composite good to face transactions during the period.

and consumption indices. As in d'Aspremont et al. (1989) we use the expression Ford effects to designate the behaviour implicit in this assumption.[8]

Here we assume the number of firms in the non-tradable sector to be fixed in the short run. To be consistent with the long-run equilibrium, this number, m, is given by the zero profit condition in the steady state. We will return to this subject later.

At the moment, we are interested in a symmetric equilibrium where every single firm produces the same quantity and sets the same price. Consequently, the following condition must hold

$$q_{i,t}^{NT} = q_{h,t}^{NT} \qquad \forall\, i \neq h \qquad (i, h = 1, ..., m) \tag{19.}$$

Finally, each firm in this sector uses a type of labour traded in a competitive market, therefore they act as a price takers.

In our model, firm i will consider equations (4.), both consumption indices definitions, (7.), and (13.) to (18.) in its own maximisation program. Bearing in mind there is no capital accumulation, the problem is static, and the first order conditions under (19.) correspond to

$$p_t^{NT} = \frac{1+m-\alpha}{m-\alpha} \,.\, w_t^{NT} \tag{N.1.}$$

$$N_{i,t}^{NT} = 1.\, q_{i,t}^{NT} \qquad (i = 1, ..., m) \tag{N.2.}$$

Equation (N.1.) represents firm i's supply in a symmetric equilibrium. Given the number of firms in the sector and other firm's production, price is proportional to the wage rate in its relevant labour market. This is the Nash solution to the standard equation of real marginal revenue to real marginal cost. In equation (N.2.) we have firm i's demand for labour, which corresponds to the inverted production function.

In the presence of a dynamic behaviour with Cournot competitors, we have multiple equilibria corresponding to different dynamic strategies. Here, we chose one type of strategy, the pure non co-operative one, and assumed every competitor to follow it in every period. In fact, and in the absence of punnishments, this strategy is dominant since there is always an individual incentive to defect even after a long period of co-operative behaviour.

[8] The original expression refers to the ability of an individual oligopolistic producer to compute the effect of its own output on total output and, therefore, on total wage income in the economy. In our dynamic setting, we assume the same type of conjectures to be focused on aggregate consumption and price levels, and not directly on the wage income.

Since every producer takes into account the effect of its production on both aggregate prices and consumption, marginal cost and marginal revenue differ from those presented on usual oligopoly models. Here we have

(N.3.) a,b $$MC_{i,t} = MC^{*}_{i,t} - \eta_{i,t} .\, RAVC_{i,t} \wedge MR_{i,t} = MR^{*}_{i,t} - \eta_{i,t} .\, RAR_{i,t} \qquad (i = 1, ..., m)$$

where $MC_{i,t}$ and $MR_{i,t}$ represent, respectively, firm i's real marginal cost and revenue. $MC^{*}_{i,t}$ and $MR^{*}_{i,t}$ stand for the same functions, but in the absence of Ford effects, $\eta_{i,t} = \left(\partial P_t / \partial q^{NT}_{i,t}\right).\left(q^{NT}_{i,t} / P_t\right)$ is the aggregate price index-firm i's production elasticity, $RAVC_{i,t}$ real average variable cost and $RAR_{i,t}$ real average revenue.

Considering that we have to observe $RAR_{i,t} - RAVC_{i,t} > 0$ in order to get a non-zero optimal production, if $\eta_{i,t} = 0$ this firm will produce, as we expected, the same quantity as in the standard Cournot oligopoly models.

Under the symmetric equilibrium considered above, we can derive a reduced form for this elasticity

(N.4.) $$\eta_{i,t} = -\frac{1-\alpha}{m} \leq 0 \qquad (i = 1, ..., m)$$

Here we can observe its value tends to zero when α tends to one, i.e. a strong preference for the tradable good, or m tends to infinity, i.e. a large number of firms in the non-tradable good sector.

We can also compute firm i's mark-up over real marginal cost in this situation

(N.5.) $$\mathcal{M}_{i,t} = \frac{\left(p^{NT}_t / P_t\right)}{MC^{NT}_{i,t}} = \frac{1}{1+\nu_{i,t} - \eta_{i,t}} = \frac{m}{m-\alpha} \qquad (i = 1, ..., m)^{9,\,10}$$

where $\nu_{i,t} = -1/m$ is the reciprocal of the price elasticity of demand faced by producer i. We can easily see it is a decreasing function of m. When we consider the limit of this expression when α tends to unity, i.e. when the share of non-tradable good sector in the economy tends to zero, we have the standard mark-up in a Cournot oligopoly. When we consider the limit of this expression when α tends to zero, i.e. when the share of non-tradable good sector in the economy tends to one, consideration of the Ford effects compels the firms to behave as under perfect competition.

[9] This definition of mark-up is different from the one traditionally used in Industrial Organization, corresponding to the Lerner index ($\mu^{L}_{i,t}$). Of course, it is easy to see that $\mathcal{M}_{i,t} = 1/\left(1-\mu^{L}_{i,t}\right)$ (i = 1, ..., m).

[10] Here the price-wage ratio differs from the mark-up expression due to the Ford effects.

2.5. The rest of the world

We consider the rest of the world supplies or purchases any quantity of the tradable good at the current price level. Definition of net exports is given by the difference between domestic supply and demand for tradable good

(X.1.) $$X_t = q_t^T - D_t^T$$

Then, we are interested in the current account. Defining it in terms of domestic currency, after the budget constraints, we have

(X.2.) $$CA_t = p_t^T . X_t + i_{t-1} . P_{t-1} . F_{t-1}$$

where CA_t, on the left-hand side, is the current account and we have, on the right-hand side, the value of net exports and net interest income transfer.[11]

3. A BENCHMARK INITIAL STEADY STATE

3.1. Finding a closed form solution to the general model

Before characterising the steady state, let us introduce an extra equation derived from the budget constraints for domestic and foreign agents

(20.) $$C_t + G_t = y_t + r_{t-1} . F_{t-1} - \Delta F_t$$

where y_t is the level of aggregate output, measured in units of consumption composite good, given by definition

(21.) $$y_t = \frac{p_t^T}{P_t} . q_t^T + p_t^{NT} \frac{p_t^{NT}}{P_t} . \sum_{i=1}^{m} q_{i,t}^{NT}$$

Equation (20.) takes the following form in the steady state, giving us the intertemporal budget constraint

[11] For sake of simplicity we assume the representative household's share on foreign firms to be zero.

(22.) $C^* + G^* = y^* + r^* . F^*$[12]

This equation implies that total domestic consumption of composite good has to match total domestic output plus interest income coming from net foreign assets. Under this condition is impossible for domestic agents to pursue a unlimited borrowing policy playing Ponzi games with international lenders.

Using (H.1.) and (8.) we find the steady state equilibrium relation between the values of nominal and real interest rates, and the discount factor. In a small open economy we assume this condition to hold in order to have a zero growth steady state

(23.) $$i^* = r^* = \frac{1-\beta}{\beta}$$

In the initial steady state the level of net foreign assets is undetermined and, consequently, we can set its value exogenously. In order to get a closed-form solution to the steady state values of the variables, given the number of firms in the non-tradable good sector, we assume net foreign assets and government consumption both to be zero, i.e. $G^* = F^* = 0$. Since government budget has to balance in the steady state, we assume positive values for firm's taxes to be offset by benefits given to the household, i.e. $m.\tau^{NT} = -\tau^h \equiv -T^h / P^*$.

However, the number of firms in the non-tradable good sector is not an exogenous variable. Its value is given by the zero profit condition for each identical firm in the sector. It is easy to check this condition turns to be a non-algebraically solvable equation in *m*. Therefore, this number has to be found through numerical methods.

3.2. A closed-form solution to the model given m

In order to get the solution to the steady state values we are proceeding in two steps. First, we will solve for the relevant variables assuming *m* to be exogenous. Then, we will introduce the zero profit condition to obtain an equation giving us the value of *m*.

Steady state real consumption is thus given by

(BSS.1.) $$C^* = \left[\left(f(m).\xi \right)^{\alpha - 1} . \left(\frac{\alpha.\phi}{\xi} \right)^{\alpha.\phi} \right]^{\frac{1}{\rho}}$$

[12] Asterisks stand for benchmark steady state values.

where $f(m) = (1+m-\alpha)/[(1-\alpha).(m-\alpha)]$ and $\rho = \mu-\gamma.[1-\alpha.(1-\phi)]>0$.

To obtain all the other endogenous variables in the model, including m, is useful to obtain the steady state value for consumption of non-tradable good, which is given by

$$\text{(BSS.2.)} \qquad C^{NT^*} = \left[f(m)^{\phi.\gamma.\alpha-\mu} . \frac{(\alpha.\phi)^{\phi.\gamma.\alpha}}{\xi^{\mu}} \right]^{\frac{1}{\mu.\rho}}$$

Notice that, since $\alpha-1 \leq 0$, $\phi.\gamma.\alpha-\mu < 0$, and $f'(m) < 0$, C^* and C^{NT^*} are both non-decreasing functions of m.

Finally, using (BSS.1.) and (BSS.2.) in the zero profit condition for each non-tradable good firm

$$\text{(BSS.3.)} \qquad \pi_i^{NT^*} = 0 \Leftrightarrow \frac{\xi. C^{*1-\gamma}. C^{NT^{*\mu}}}{m.(m-\alpha)} = \tau^{NT} \qquad (i = 1, ..., m)$$

3.3. Comparing different initial steady states

Using the values obtained for the benchmark steady state and the relevant behavioural equations, we can log-linearise the system around that particular point. The system of equations we obtain is the following

$$\text{(LR.1.)} \qquad \hat{D}^{NT^*} = \hat{P}^* + \hat{D}^* - \hat{p}^{NT^*}$$

$$\text{(LR.2.)} \qquad \hat{D}^{T^*} = \hat{P}^* + \hat{D}^* - \hat{p}^{T^*}$$

$$\text{(LR.3.)} \qquad \hat{D}^* = \frac{1-\beta}{\beta}. \hat{F}^* + \hat{y}^*$$

$$\text{(LR.4.)} \qquad \hat{P}^* = \alpha. \hat{p}^{T^*} + (1-\alpha). \hat{p}^{NT^*}$$

$$\text{(LR.5.)} \qquad \hat{C}^* = \hat{D}^* - \hat{G}^*$$

$$\text{(LR.6.)} \qquad \hat{m}^* = a_1.\left[\mu. \hat{D}^{NT^*} + (1-\gamma). \hat{C}^*\right]$$

$$\text{(LR.7.)} \qquad \hat{y}^* = \alpha. \hat{q}^{T^*} + (1-\alpha). \hat{D}^{NT^*}$$

$$\text{(LR.8.)} \qquad \hat{q}^{T^*} = \frac{\phi}{\mu-\phi}.\left[\hat{p}^{T^*} - (1-\gamma). \hat{C}^* - \hat{P}^*\right]$$

$$\text{(LR.9.)} \qquad \hat{p}^{NT^*} = (\mu-1). \hat{D}^{NT^*} + (1-\gamma). \hat{C}^* + \hat{P}^* - a_2. \hat{m}^*$$

Variables with hats represent its long-run percentage deviation from the benchmark steady state and can be defined as $\hat{H}^* = dH^*/H^*$. An exception has to be made for $\hat{G}^*$ and $\hat{F}^*$ because its equilibrium values in the benchmark steady state were set to zero. Therefore, we define its permanent log-deviations with respect to the consumption of composite good $\hat{G}^* = dG^*/C^*$ and $\hat{F}^* = dF^*/C^*$.[13]

The values for the new parameters, considering $m \geq 2$, are given by $a_1 = (m-\alpha)/(2m-\alpha)$ and by $a_2 = m/[(m-\alpha).(1+m-\alpha)]$. From these expressions we can see that $1/3 \leq a_1 \leq 1/2$ and $0 < a_2 \leq 1$.

Equations (LR.1.) and (LR.2.) are the log-linear forms of, respectively, (16.) and the sum of (H.2.) and (G.1.), where $D_t^T = C_t^T + G_t^T$ is the total demand for tradable good, both corresponding to market demand functions for the two goods in the economy. (LR.5.) is derived from the definition of total demand for composite good, already used to derive (16.). (LR.3.) corresponds to (22.) and (LR.4.) is the log-linear form of the price index definition given by (4.). (LR.6.) comes from the zero profit condition represented by (BSS.3.), but has a different presentation. The aggregate output definition in (21.) under the benchmark steady sate constraints, where it equals aggregate consumption, is the main equation behind (LR.7.). The equilibrium in the 'tradable good' labour market given by (H.4.)a, and (T.2.) is the foundation for (LR.8.). Finally, (LR.9.) is obtained through a similar process using equations (H.4.)b, (N.1.) and (N.2.).

However, the value for $\hat{F}^*$ is not exogenous. A steady-state permanent increase in the level of net foreign assets does not depend only on permanent shocks, but also on temporary ones occurring between steady states. Therefore, $\hat{F}^*$ is path-dependant and has to be sorted out through dynamic analysis. We will observe it in more detail when studying the dynamic features of the model.

We assume government, when changing balanced budget fiscal policy with respect to the benchmark steady state, to finance itself using the following rule $\hat{G}^* = \left(\tau^h.\hat{\tau}^{h^*} + m.\tau^{NT}.\hat{m}^*\right)/C^*$, where we know that $\tau^h < 0$ in order to generate positive fixed costs with zero total taxes in the benchmark steady state. Therefore, we are assuming government to finance itself using only the lump-sum tax on households and taking into account the effect of free entry on its tax revenues.

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[13] Remember they are both expressed in units of consumption composite good.

3.3.1. Varying the initial conditions

Considering net foreign assets percentage deviation from the benchmark steady state aggregate consumption path as an exogenous variable, we can write the log-linear system on its matrix form

(LRS.1.) $\mathbf{A^*}.\mathbf{Y^*} + \mathbf{B^*}.\mathbf{X^*} = \mathbf{0}$

where $\mathbf{Y^*}$ is the vector containing the endogenous variables, $\mathbf{X^*}$ the vector with the exogenous variables, each one given by $\mathbf{Y^*} = [\hat{D}^{NT^*} \quad \hat{D}^{T^*} \quad \hat{D}^* \quad \hat{P}^* \quad \hat{C}^* \quad \hat{m}^* \quad \hat{y}^* \quad \hat{q}^{T^*} \quad \hat{p}^{NT^*}]^{\mathrm{T}}$ and $\mathbf{X^*} = [\hat{G}^* \quad \hat{F}^* \quad \hat{p}^{T^*}]^{\mathrm{T}}$. $\mathbf{A^*}$ and $\mathbf{B^*}$ are the structural matrices derived from (LR.1.) to (LR.9.).

The solution to (LRS.1.) is given by

(LRS.2.) $\mathbf{Y^*} = [\mathbf{A}^{*-1}.(-\mathbf{B}^*)].\mathbf{X^*}$

where the reduced form matrix is $\mathbf{\Sigma} = [\mathbf{A}^{*-1}.(-\mathbf{B}^*)] = [\sigma_{H,Z}]$. H is an endogenous entering $\mathbf{Y^*}$ and Z is an exogenous variable entering $\mathbf{X^*}$. Results are shown in Table I.

3.3.2. Government expenditure

We start analysing the impact of a one per cent increase in government purchases assuming the same levels for net foreign assets and tradable good price. First, we assume m to be constant, then we introduce free entry and compare both equilibria.

Since the budget has to balance, fiscal expansion induces a decrease in private consumption. Therefore, labour supply expands forcing down nominal wages. In the non-tradable good sector, this implies a price decrease and an output expansion. Higher profits are produced and, when we consider free entry, the price-wage ratio decreases inducing the price to fall and output to rise even further.

In the tradable good market, the wage decrease induces a supply and output expansion. When we consider free entry in the non-tradable good market, and assuming γ to be sufficiently lower than unity,[14] since the price of this good is not affected, the labour supply expansion is smaller and so is the output increase. In both cases, demand has to meet supply, since we are considering net foreign assets stay at its benchmark steady state level.

[14] I.e. the intertemporal elasticity of substitution, given by $1/(1-\gamma)$, to be small enough.

Now, we know the static effect of a marginally different fiscal policy, with constant net foreign assets and price for the tradable good, on both the tradable good and the non-tradable good outputs, either with a fixed number of firms in the Cournot sector and allowing for this number to vary. Though, can we unambiguously compare the effects of fiscal policy in the aggregate output with and without free entry?

If there is a large elasticity of intertemporal substitution, it is easy to see that both types of output have a bigger expansion under free entry. However, in the more plausible case of a small positive or even negative value for γ, the ranks are different in the two markets, has we observed before. The ratio between the fiscal multipliers with and without free entry is given by

$$\frac{\left.\sigma_{y,G}\right|_{\mathrm{NE}}}{\left.\sigma_{y,G}\right|_{\mathrm{FE}}} = 1 - \frac{(1-\alpha).\,a_1.\,a_2}{\rho.(1-a_1.\,a_2)} < 1$$

where $\left.\sigma_{y,G}\right|_{v} = \left.\left(\hat{y}^* / \hat{G}^*\right)\right|_{v,\,\hat{F}^*=0,\,\hat{p}^{T^*}=0}$ (v = FE, NE), FE = free entry and NE = no entry.

Since both multipliers are positive, we can show unequivocally that the static fiscal multiplier is larger under free entry, i.e. the direct effect of free entry on price for the non-tradable good prevails over the spillover effect on the tradable good market.

This result contrasts with Startz (1989) where the free entry static fiscal multiplier is smaller than the no-entry one. There are many differences between our model and Startz's one: oligopoly, instead of Dixit-Stiglitz monopolistic competition, the existence of Ford effects, the dynamic foundations, the open economy and two-products approach, etc. However, as pointed out in Dixon and Lawler (1996), special assumptions on preferences and firms' technology are crucial to that result. Here too our model differs from Startz's and from the Dixon (1987), Mankiw (1988) and Startz (1989) (DMS) tradition.

A small reduction in the lump-sum tax per firm producing the non-tradable good, with an increase in the household lump-sum tax in order to leave total taxes unchanged, induces a small increase in *m*, the number of firms in the non-tradable good sector and, therefore, a reduction in the mark-up. We may use this result to analyse the way imperfect competition affects the static multipliers. The sensibility of the free-entry multiplier to an exogenous increase in *m* is given by

$$\frac{d\left.\sigma_{y,G}\right|_{\mathrm{FE}}}{dm} = \frac{(1-\gamma).\left[1-\alpha.(1-\phi)\right]}{\rho+(1-\alpha)}.\left[1-\frac{\rho}{\rho+(1-\alpha)}\right].\,z'(m)$$

where $$z'(m) = \frac{d(a_1 . a_2)}{dm} = -\frac{2m^2 + \alpha . (1-\alpha)}{(2m-\alpha)^2 . (1+m-\alpha)^2} < 0$$

As we can see, a small step towards a more competitive situation reduces the effectiveness of fiscal policy under free entry. DMS results connecting fiscal multipliers and imperfect competition are, therefore, extended to a free entry situation.

3.3.3. Net foreign assets

Analysing the effects of small changes in the initial level of net foreign assets proved to be an arduous task. Even considering entry is not possible, we can only derive unambiguous signs to some of the static multipliers in the second column of Table I. An increase in the initial level of net foreign assets corresponds to a higher level of wealth and, therefore, to a higher level of steady state consumption. Demand for the non-tradable good and labour expands. However, the 'non-tradable' labour supply contracts. For a higher elasticity of intertemporal substitution ($\gamma > 0$), present and future consumption are imperfect substitutes. Therefore, the increase in consumption induces a small shift in the labour supply schedule. The labour demand effect prevails and we observe an increase in employment, output, wage and price. Nonetheless, if $\gamma < 0$ the contraction in labour supply prevails and we observe a decrease in employment and output, and an increase in both the wage rate and the price. If present and future consumption are perfect substitutes, besides de discount factor, there is no change in employment and output in this sector.

When we introduce free entry, complexity increases. We can unequivocally sign the static multiplier for the number of firms, which is a non-negative number. Even considering $\gamma > 0$, the reduction in output corresponds to an increase in the price allowing profits to go up. The aggregate consumption static multiplier is non-negative, as well. However, the decrease in the price-wage ratio generates further effects on both markets, particularly on goods' demands and labour supplies. We will return to this subject later when we analyse the dynamic effects of a temporary fiscal shock in the full dynamic model. There, we will try to get some intuition using a numerical experiment for a plausible set of parameters.

3.3.4. Tradable good price

The world price for the tradable good in domestic currency[15] may be used as a nominal anchor in the steady state model for this small open economy. Goods' demand

[15] Remember we assumed a flat shock-free path for the nominal exchange rate.

and labour supply functions are HoDO in the aggregate price index and the latter is HoDO on prices. Hence, a one per cent increase in this price increases by one per cent the non-tradable good price and, consequently, the aggregate price index. All the per capita quantities remain unchanged and, therefore, so does *m*.

4. SHORT-RUN ANALYSIS

4.1. The log-linearised model in the short run

In order to analyse the dynamic behaviour of the model between steady states, we will log-linearise it around the benchmark steady state path derived before.

The set of equations is similar to (LR.1.) to (LR.9.)

(SR.1.) $$\hat{D}_t^{NT} = \hat{P}_t + \hat{D}_t - \hat{p}_t^{NT}$$

(SR.2.) $$\hat{D}_t^{T} = \hat{P}_t + \hat{D}_t - \hat{p}_t^{T}$$

(SR.3.) $$\hat{F}_t = \frac{1}{\beta}.\,\hat{F}_{t-1} + \hat{y}_t - \hat{C}_t - \hat{G}_t$$

(SR.4.) $$\hat{P}_t = \alpha.\,\hat{p}_t^{T} + (1-\alpha).\,\hat{p}_t^{NT}$$

(SR.5.) $$\hat{D}_t = \hat{G}_t + \hat{C}_t$$

(SR.6.) $$\hat{C}_t = \hat{C}_{t-1} + \frac{1-\beta}{1-\gamma}.\,\hat{i}_{t-1} - \frac{1}{1-\gamma}.\left(\hat{P}_t - \hat{P}_{t-1}\right)$$

(SR.7.) $$\hat{y}_t = \alpha.\,\hat{q}_t^{T} + (1-\alpha).\,\hat{D}_t^{NT}$$

(SR.8.) $$\hat{q}_t^{T} = \frac{\phi}{\mu-\phi}.\left[\hat{p}_t^{T} - (1-\gamma).\,\hat{C}_t - \hat{P}_t\right]$$

(SR.9.) $$\hat{p}_t^{NT} = (\mu-1).\,\hat{D}_t^{NT} + (1-\gamma).\,\hat{C}_t + \hat{P}_t$$

There are some differences between this set and the long-run one. (SR.3.) is derived from (20.) instead of (22.). (SR.6.) is the log-linear version of the Euler equation given by (H.1.), but expressed in terms of present consumption, and considering (8.) and (SR.9.) where the effect of a change in the number of firms in the non-tradable good sector disappears since there is no free entry in the short run.

In this system, variables with hats represent its short-run percentage deviation from the benchmark steady state path and can be defined as $\hat{H}_t = dH_t/H_t\big|_{H_t=H^*} = dH_t/H^*$.

Again $\hat{G}_t$ and $\hat{F}_t$ are defined as the short-run log-deviations with respect to the benchmark steady state path of aggregate consumption $\hat{G}_t = dG_t/C^*$ and $\hat{F}_t = dF_t/C^*$.

As we did with the long-run system, we can express the short-run one in its matrix form

(SRS.1.) $\mathbf{A}.\,\mathbf{Y}_t + \mathbf{B}.\,\mathbf{X}_t + \mathbf{C}.\,\mathbf{Y}_{t-1} = \mathbf{0}$

where $\mathbf{Y}_t = \left[\hat{D}_t^{NT} \quad \hat{D}_t^{T} \quad \hat{F}_t \quad \hat{P}_t \quad \hat{D}_t \quad \hat{C}_t \quad \hat{y}_t \quad \hat{q}_t^{T} \quad \hat{p}_t^{NT}\right]^{\mathrm{T}}$ and $\mathbf{X}_t = \left[\hat{G}_t \quad \hat{i}_{t-1} \quad \hat{p}_t^{T}\right]^{\mathrm{T}}$.

It is noteworthy to recognize these vectors do not correspond completely to the steady state vectors. Our option was to maintain the equations' order rather than the endogenous variables' order. Therefore, short-run log-deviations for aggregate consumption and demand changed their place with the introduction of net foreign assets deviation as an endogenous variable.

The solution to (SRS.1.) is given by

(SRS.2.) $\mathbf{Y}_t = \left[\mathbf{A}^{-1}.\,(-\,\mathbf{B})\right].\,\mathbf{X}_t + \left[\mathbf{A}^{-1}.\,(-\,\mathbf{C})\right].\,\mathbf{Y}_{t-1} = \Theta.\,\mathbf{X}_t + \mathbf{\Omega}.\,\mathbf{Y}_{t-1}$

Short-run multipliers in matrix $\mathbf{\Theta} = [\theta_{H,Z}]$, have a similar notation to those in $\mathbf{\Sigma}$. Reduced form matrices are presented in Tables II and III.

Let us now analyse the short-run effects of fiscal policy on some of the most important endogenous variables. We assume the other exogenous variables to stay at its steady state levels, i.e. $\hat{i}_{t-1} = 0$ and $\hat{p}_t^T = 0$. For sake of simplicity we assume the economy to be on the benchmark steady state in period *t*-1.

4.1.1. Fiscal policy

In the non-tradable good market, government spending in period *t* expands demand for the good and labour. Nominal wage increases pushing up the price of the good. The aggregate price index goes up expanding demand for the good even further, and reducing labour supply. Simultaneously, given the international nominal interest rate, inflation reduces the real interest rate pushing down aggregate consumption. Nevertheless, this effect is not able to offset the previous one and both output and price increase in this market.

In the 'tradable' labour market, aggregate price and consumption effects offset each other leaving labour supply unchanged. Given the price of the good is constant, labour demand does not change and nor does the good's supply and domestic production.

The demand expansion induces a current account deficit which has to be compensated by a net foreign debt situation at the end of period *t*.

Aggregate output and prices increase in the short run driven by the non-tradable good sector.

4.2. Single-period fiscal shocks

In order to study and compare both the long-run and the short-run effects of temporary fiscal shocks, we are going to concentrate on single-period shocks. As we did in the previous sub-section, here we assume the economy to be in its benchmark initial steady state in period t=0. Then an unexpected fiscal shock hits it in period t=1 and vanishes from period t=2 onwards.

Shocks will be studied separately, i.e. we assume there are no changes in the other exogenous variables when analysing one in particular. It is possible to do that with no significant lost since our model is linear in the percentage changes of exogenous variables. Therefore, the total effect of a combined shock can be obtained through the addition of the partial effects.

Let us now take a closer look at the structural form of the model operating under this type of shocks. We only have two dynamic equations, (SR.3.) and (SR.6.), and in both of them we can observe one period lags in the endogenous variables. Furthermore, there is a unit root present in the dynamic system, coming from the consumption Euler equation, inducing permanent effects from temporary shocks. Therefore, transition between steady states is concentrated in period t=1 and a new steady state is achieved in period t=2, allowing us to handle the model as a two-period one under this particular type of shocks.[16]

Considering these assumptions, we can simplify notation ignoring time subscripts. Hence, we will use $\hat{H}$ for the percentage deviation from benchmark the steady state value in period t=1 (short run), and $\hat{H}^*$ for the steady state percentage deviations from the benchmark path, i.e. the log-deviation of the variable in period t=2 (long run).

Thus, considering asset stocks are at their new steady state levels at the end of period t=1, (SR.3.) gives us an additional equation linking the short run (period t=1) and the long run (period t=2)

[16] The same features can be noticed in Obstfeld and Rogoff (1995) and Sutherland (1996). In both these papers there is an additional short-run constraint arising from one-period price stickiness.

(LR.10.) $\hat{F}^{*} = \hat{F} = \hat{y} - \hat{C} - \hat{G}$

which show us the percentage deviation of net foreign assets in the new steady state from its value in the initial one, is given by its value at the end of period t=1, both being determined by the change in the current account deficit during the transition period.

The present approach can also be applied to permanent shocks, using the steady state log-linearised model to consider changes in the exogenous variables from period t=2 onwards.

5. LONG-RUN ANALYSIS

5.1. A temporary fiscal shock

Let us analyse the long-run effect of a unanticipated one per cent increase in government purchases, occurring in period t=1 and vanishing afterwards.

As we noticed in the short-run model, this new path for fiscal policy will have a 'surprise effect' on period t=1, the transition period, and the long-run log-deviations from the initial steady state path are given by

$$\mathbf{Y}^{*}\Big|_{\text{Temp}} = \mathbf{\Sigma}.\begin{bmatrix} 0 \\ \hat{F} \\ 0 \end{bmatrix} \text{ and } \hat{G}_t = \begin{cases} 1 & \Leftarrow t = 1 \\ 0 & \Leftarrow t \geq 2 \end{cases}$$

where 'Temp' means a temporary fiscal shock.

This surprise effect reduces the level of net foreign assets by $-\theta_{F,G} = (1-\gamma).\alpha.\mu/\varphi$ per cent from its zero level in the initial steady state path. Assuming no other changes will take place in period t=2, the stock of net foreign assets from period t=2 onwards is given by its level at the end of period t=1, as stated in equation (LR.10.). The effect on each steady state endogenous variable is given by the product of $\theta_{F,G}$ by the correspondent static multiplier in matrix $\mathbf{\Sigma}$.

Though, signing the static multipliers for small steady state deviations on the stock of net foreign assets, is not quite straightforward. We will proceed in two steps to derive some economic intuition from these general multipliers. First, we will study the effects when there is no free entry in the long run, assuming the elasticity of intertemporal substitution to be smaller than unity. Ruling out values for γ between 0 and 1 is not as restrictive as it can look at first sight. Numerical experiments proved to be hard to find a feasible equilibrium with a positive value for γ. In addition, a non-positive value for γ entails an infinite disutility for a zero aggregate consumption, which is an interesting feature from a macroeconomic point of view. Finally, we will run a numerical experiment using plausible values for the parameters, following Hairault and Portier (1993) and Sutherland (1996), to obtain a more extensive explanation of the free-entry model, even if not as general as the previous investigation.

A permanent net foreign assets reduction implies a consumption decrease. Consequently, demand for goods contract and labour supplies expand. In the non-tradable good market, demand contraction decreases labour demand, forcing the nominal wage rate to go down. The price decreases and so does the aggregate price index reinforcing the consumption effect. The new long-run equilibrium output is higher than in t=0, but lower than in t=1. The aggregate price index is lower than in the two previous periods.

The 'tradable' wage rate decrease stimulates the tradable good supply and output. Since demand contracted, we now have a permanent trade surplus to compensate the short-run deficit.

Without free entry, long-run aggregate consumption decreases and aggregate output increases with a temporary fiscal expansion.The situation we described before, generated negative profits in the non-tradable good sector and, with the possibility of entry, m goes down by $-\sigma_{m,F}.\theta_{F,G}$ per cent, increasing the price-wage ratio and pushing up nominal variables.

Two other variables have their percentage deviations from the initial steady state unambiguously determined: agrregate consumption and aggregate ouput, the latter considering the constraint on the value of the elasticity of intertemporal substitution. In the case of consumption, the effect of free entry on the non-tradable good price implies an additional reduction, setting the log-deviation from initial steady state in $\sigma_{C,F}.\theta_{F,G}$.

In the case of output, it is possible to see both static multiers, with and without free entry, are negative.[17] Therefore, its ratio has to be a positive number, given by

$$\frac{\sigma_{y,F}\big|_{\text{FE}}}{\sigma_{y,F}\big|_{\text{NE}}} = 1 + \frac{(1-\alpha).(\mu-\phi).a_1.a_2}{\upsilon.\Delta} < 1$$

[17] It is easy to demonstrate this proposition when $\gamma \leq -1$. For $\gamma \in (-1,0)$, we ran numerical simulations, similar to those presented in appendix A. No economically plausible equilibrium was found that could generate a non-negative multiplier.

where $\upsilon = (\mu - \phi) - \rho \leq 0$. The consequence is that the modulus of the free entry multiplier is smaller than the modulus of the no-entry multiplier. Consequently, for the same reduction in the level of net foreign assets, there is a smaller positive impact on aggregate output coming from the free entry situation than it would be in its absence.

Let us now run a numerical experiment using the values in Table IV. The values for β, χ and ε are immediatly transposed from Sutherland (1996). The value of γ arises from the elasticity of intertemporal substitution in that paper (0.75). The value for τ^{NT}, given the other values for the parameters, implies an initial steady state value of (approximatelly) 6 for m, which means a price-wage ratio of the same magnitude in the steady state. The value for μ is also taken from Sutherland (1996) even if there is no direct relation between the two since he considers only one type of labour. However, it is not easy to find a relationship between the two types of model in order to derive another value, as we did for γ. The values for α and ϕ are purely for illustration and imply some sensivity on the importance of the open economy assumption and the contribution of labour input to the tradable good output. The parameter ξ is important only to define the initial steady state levels and, therefore, we used it to control some plausibility in the absolute values.

With this set of values, we generated a decrease in the level of net foreign assets in period t=1 of $-\theta_{F,G}$ = 0.65652 per cent in response to a single-period one per cent increase in government purchases.

The second column in matrix Σ shows the values presented in Table V. Every impact value is very similar to the no entry situation. For this set of values, the temporary fiscal shock as little influence on the number of firms and, therefore, on other steady state variables. However, let us focus on relative values and not on absolute ones. As we predicted on the general model, the fall on the level of net foreign assets induces a lower number of firms in the non-tradable good sector in order to generate a zero-profit equilibrium. The price-wage ratio increases pushing up the price for the non-tradable good and, since demand for it is lower now, demand for labour decreases as well. Lower aggregate consumption also pushes in the same direction and the aggregate price effect is not big enough to offset the combination of the previous two. This explains why output is lower and the price is higher in the non-tradable good sector.

In the tradable good market, the aggregate consumption effect contracts labour supply and, simultaneously, expands the good's demand. As a result the nominal wage goes down, expanding the good's supply. The aggregate price index effect is, once again, unable to totally offset the effect of consumption. In both situations, the trade surplus remains unchanged since it has to offset the same short-run debt level.

5.2. A permanent fiscal shock

Permanent shocks have two separate effects on endogenous variables: a 'surprise effect', exactly as the temporary shock, and a steady state effect, as in the static models. Log-deviations from their initial steady state path are given by

$$\mathbf{Y}^*\big|_{\text{Perm}} = \boldsymbol{\Sigma}.\begin{bmatrix} 1 \\ \hat{F} \\ 0 \end{bmatrix} \text{ and } \hat{G}_t = 1,\ \forall t \geq 1$$

where 'Perm' means a permanent fiscal shock.

Since we have analysed both effects in detail, let us just have a closer look at the aggregate output effect. A permanent fiscal shock of one per cent, measured in terms of the initial steady state aggregate consumption, is given by $\hat{y}^* = \sigma_{y,F}.\theta_{F,G} + \sigma_{y,G}$. Given the restriction we made on the value of γ, both effects are positive. Thus, total effect of a permanent fiscal shock is, in fact, greater than the static DMS type multiplier effect. The previous expression is also equivalent to $\hat{y}^* = 1 + \left(\sigma_{y,F}.\theta_{F,G} + \sigma_{C,G}\right)$.

Therefore, the size of the long-run aggregate output percentage deviation due to a permanent increase in government purchases by one per cent, is not clearly inferior to one, as in the traditional static approach. The combination of the open economy and the dynamic setting effects pushes long-run aggregate output even further above its initial steady state path. In our numerical experiment, this effect implies an extra increase of 0.024 per cent both with and without free entry.

6. WELFARE ANALYSIS

6.1. Utility flows

Let us now evalute the impact of fiscal policy from the point of view of the household's flow of utility. This element is crucial to develop a complete welfare analysis afterwards.

Using our log-linearised model, we can compute the differential of the household's utility flow as a function of (short-run) log-deviations from the initial steady state path, using (1.)

Since the money supply is endogenous in this model, we have to derive the per capita real money balances log-deviation from its initial steady state path using equation (H.5.). Thus, we obtain the following reduced form

$$\text{(W.1.)} \qquad dU_t = u_C . \hat{C}_t - u_{N^T} . \hat{N}_t^T - u_{N^{NT}} . \hat{N}_t^{NT} - u_{i^F} . \hat{i}_t^F$$

$$u_C = C^{*\gamma} + \frac{\chi.(1-\gamma)}{\varepsilon} . \left(\frac{M^*}{P^*}\right)^{1-\varepsilon},\ u_{N^T} = \xi . N^{T^*},\ u_{N^{NT}} = \xi . N^{NT^*},\ u_{i^F} = \frac{\chi . \beta}{\varepsilon} . \left(\frac{M^*}{P^*}\right)^{1-\varepsilon}$$

We know the production technologies and the multipliers associated with both long and short runs. First, let us have a look at the short-run deviation from the initial steady state path when we have a one per cent increase in period t=1 government purchases (either permanent or temporary shock) $dU = u_C . \theta_{C,G} - u_{N^{NT}} . \theta_{D^{NT},G} \leq 0$. In the short run, the negative effect of fiscal policy on consumption and its positive effect on the non-tradable good output, implying need to work more in this sector,[18] have a negative effect on the household's utility flow.

In period t=2, the new steady state, flow utility is given, in case of a temporary fiscal shock by

$$dU^*\Big|_{\text{Temp}} = u_C . \sigma_{C,F} . \theta_{F,G} - u_{N^T} . \frac{\sigma_{q^T,F}}{\phi} . \theta_{F,G} - u_{N^{NT}} . \sigma_{D^{NT},F} . \theta_{F,G}$$

When free entry is not possible in the long run, the reduction of consumption and expansion of both outputs imply a fall in the flow of utility. Considering free entry, consumption presents a smaller decrease and, given our numerical simulation, employment has a larger expansion on the non-tradable good sector and a smaller expansion on the tradable good sector. Although the fall in the utility flow is smaller under free entry, there is still a mainly walrasian effect. Actually, a temporary fiscal shock, reduces the number of firms increasing the mark-up, which means a more imperfect market for the non-tradable good.

When we consider a permanent shock, the effect on the utility flow is given by

$$dU^*\Big|_{\text{Perm}} = dU^*\Big|_{\text{Temp}} + u_C . \sigma_{C,G} - u_{N^T} . \frac{\sigma_{q^T,G}}{\phi} - u_{N^{NT}} . \sigma_{D^{NT},G}$$

Considering the non-tradable good output (and employment) static multiplier is positive, the last term on the right-hand side of the equation gives us an additional

[18] Remember the tradable good output remains the same in the short run.

source of disutility coming from the permanent increase in government purchases. However, the aggregate consumption static multiplier cannot be said to be unambiguously negative. Using the familiar relationship between this static multiplier and the aggregate output one, we have $\sigma_{C,G} = \sigma_{y,G} - 1$.

Therefore, a necessary condition, even if not sufficient, to have an increase in the steady state utility flow, is the (aggregate output) static fiscal multiplier has to be greater than one. But is it plausible, considering the assumptions we made? In our numerical experiment the static fiscal multiplier is less than one (0.8083), inducing a negative effect on steady state aggregate consumption and, consequently, a decrease in period t=2 utility flow. However, using another set of parameters, it is possible to produce a positive static effect on consumption, namely, if we allow for a more imperfectly competitive economy: larger preference for the non-tradable good (a smaller α) and a smaller number of firms in the non-tradable good sector (m) in the initial steady state.

It is not easy to get some intuition relating α and m to changes in steady state flow utility. Both the steady state fiscal multiplier ($\sigma_{y,G}$) and the reduced form derivative of flow utility with respect to aggregate consumption (u_C), the crucial parameters in this case, depend on α and m.[19] It is not difficult to observe the price-wage ratio (and the mark-up) depends negatively on m. Therefore, when we consider an initial steady state with a small number of firms, the negative effect of a permanent fiscal expansion on the price-wage ratio will be larger, with free entry, than in an alternative initial steady state with a larger number of firms in the Cournot sector. However, the effect of α is not restricted to the mark-up. In fact, a small value for α increases both the mark-up and the price-wage ratio. For plausible values of the parameters considered, we expect the steady state multiplier to decrease with α, as happens unambiguously in the absence of free entry. At the same time, u_C follows the steady state aggregate consumption (ignoring very small values of χ). Considering a small value for α we expect aggregate consumption to depend negatively on this parameter.[20] The reason lies in the larger weight the household puts on the consumption of the non-tradable good which decreases when the price-wage ratio increases. Thus, we expect both u_C and $\sigma_{y,G}$ to be decreasing on α for small values for this parameter. This effect is intensified either

[19] Of course m depends on α as well, but when we calibrate the model for a given level of price-wage ratio, the number of firms in the non-tradable good sector is given by the fixed cost. Therefore, we can maintain m fixed and vary the fixed cost in order to insulate the effects of a change in α from those arising from a change in m.

[20] For larger values of α the tradable good becomes more important in aggregate consumption and the relationship is reverted.

through a larger effect of consumption on flow utility (e.g. a smaller ε) or through a smaller marginal labour disutility (e.g. smaller values for μ and ξ).

6.2. Intertemporal utility

If we want to evaluate fiscal policy using the household's intertemporal utility, instead of its steady state flow utility, we are considering the discounted effect of period t=1 utility decrease compared to a possible steady state increase. Therefore, a small change on welfare is defined as

$$dW = \sum_{t=1}^{\infty}\left(\beta^{t}.\, dU_{t}\right) = \beta.\, dU + \frac{\beta^{2}}{1-\beta}.\, dU^{*}$$

Considering our definition of welfare, a positive temporary fiscal shock is always welfare worsening and a permanent one may be welfare improving if and only if $dU^{*} > -(1-\beta)/\beta.dU$, i.e. the set of parameter values which allows a permanent one per cent increase on government purchases to be welfare improving is a subset of the one which yields the same policy change to improve the steady state utility flow.

7. CONCLUSIONS

In this work we present a dynamic model for a small open economy, generalising the mainly static approach used in models considering non-perfect competition. Even if the results of the model depend on the specific functional forms considered and, therefore, generalisations have to be carefully made, the assumptions used are quite standard in current open economy macro-models with micro-foundations.

We noticed when the individual firm in the non-perfectly competitive sector knows its size is not negligible in the whole economy, its monopoly power is reduced and the underlying general equilibrium is closer to a perfectly competitive one.

The study of the short run, when unexpected shocks hit the economy, showed a similar path to dynamic models of perfect competition. This outcome is based on the assumption of a fixed mark-up in the short run.

In the long-run, the outcomes of the model are more interesting. First, temporary fiscal shocks have a positive influence on aggregate output, but worsen welfare, as in the DMS framework. Second, permanent shocks may improve both aggregate output and welfare if we allow the non-tradable good market to be imperfectly competitive enough. The reason lies on the free-entry effect which may reduce the market power and drive the economy to a Pareto superior equilibrium. Third, the effect on aggregate output exceeds the static multiplier effect, due to the short-run effect on the net foreign assets level, and is larger under free entry. Finally, the effect of a fiscal expansion on the aggregate price index is quite surprising: it goes above the initial steady state path in the short run, but it rests bellow it when the new steady state is reached. The reason for this is not found in the imperfectly competitive framework, but the model's relationship between the price taking behaviour in the tradable good sector and domestic labour markets functioning.

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APPENDIX

The value of the matrix $\mathbf{A}^*$'s determinant will condition the sign of most of the elements of $\boldsymbol{\Sigma}$

$$\left|\mathbf{A}^*\right| = \Delta = \rho.\left(1 - a_1 .\, a_2\right) - (1 - \alpha).\, a_1 .\, a_2$$

The problem in signing Δ arises from the fact a_1 and a_2 depend on the initial value, derived in the benchmark steady state, for the number of firms in the non-tradable good sector, m. Since this variable depends on the parameter values and it cannot be derived algebraically, the task is not straight forward.

In the absence of free entry in the long run, Δ would be unequivocally positive and equal to ρ. Allowing for free entry will introduce both a positive and a negative effect through equation (LR.9.).

An equivalent condition to $\Delta > 0$ is given by $\rho > (1-\alpha).(a_1.a_2)/(1-a_1.a_2)$. It is easy to compute the boundaries for the right-hand side of the previous inequality. This expression cannot take values below the limit, when m tends to infinity, of $(1-\alpha).a_1.a_2/(1- a_1.a_2)$, which is zero, or above 1/5, which arises from $\alpha = 0$ and $m = 2$.

If $\gamma \leq 0$, ρ is always greater or equal to one and, consequently, greater than 1/5. Another sufficient condition to have a positive Δ is given by $\mu - \gamma > 1/5$ since

$$\mu - \gamma > (1 - \alpha).\frac{a_1 .\, a_2}{1 - a_1 .\, a_2} - \alpha .\, \gamma .\, (1 - \phi)$$

is an equivalent condition and $\alpha.\gamma.(1-\phi)$ is an increasing function of α, taking values from -1 to 0.

The set of parameter values generating a negative value for Δ is, therefore, a subset of the set defined by two necessary conditions corresponding to the previous ones, i.e. $0 < \gamma \leq 1$ and $\mu - \gamma < 1/5$, the zero profit condition and the existence of equilibria (positive values for prices, quantities and the number of firms). Even if we cannot demonstrate it to be an empty set, numerical experiments may help us to enlighten this issue.

In order to obtain reasonable values for Δ we ran several numerical simulations. The Gauss computer program we used had the following features:

1. used the Newton-Raphson method to approximate *m*;

2. extremely high values for *m* were ruled out;

3. values for *m* less than 2 (duopoly situation) were also ruled out;

4. infinite values for Δ were ruled out as well.

The reason behind 2 and 4 is to assure an equilibrium exists. 3 is due to the nature of the model which cannot be automatically transposed to a monopoly situation, especially when there is no integer constraint on *m*.

Gauss outputs are shown in Table VI.

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TABLES

TABLE I

STEADY STATE MULTIPLIERS IN MATRIX Σ[a, b]

	$\hat{G}^*$	$\hat{F}^*$
$\hat{D}^{NT^*}$	$\sigma_{D^{NT},G} = \frac{1-\gamma}{\mu.\Delta}.\left[\mu.(1-a_1.a_2)+\alpha.\phi.a_1.a_2\right] \geq 0$	$\sigma_{D^{NT},F} = \frac{1-\beta}{\beta.\Delta}.\frac{\mu-\phi}{\mu}.\left[\gamma.(1-a_1.a_2)+a_1.a_2\right]$
$\hat{D}^{T^*}$	$\sigma_{D^T,G} = \frac{1-\gamma}{\mu.\Delta}.\phi.\left[\mu.(1-a_1.a_2)-a_1.a_2.(1-\alpha)\right] \geq 0$	$\sigma_{D^T,F} = \frac{1-\beta}{\beta.\Delta}.\frac{\mu-\phi}{\alpha.\mu}.\left[(\mu-\gamma.(1-\alpha)).(1-a_1.a_2)-(1-\alpha).a_1.a_2\right]$
$\hat{D}^*$	$\sigma_{D,G} = \sigma_{y,G} \geq 0$	$\sigma_{D,F} = \frac{1-\beta}{\beta} + \sigma_{y,F}$
$\hat{P}^*$	$\sigma_{P,G} = (1-\alpha).\sigma_{p^{NT},G} \leq 0$	$\sigma_{P,F} = (1-\alpha).\sigma_{p^{NT},F}$
$\hat{C}^*$	$\sigma_{C,G} = \sigma_{y,G} - 1$	$\sigma_{C,F} = \frac{1-\beta}{\beta.\Delta}.(\mu-\phi).(1-a_1.a_2) \geq 0$
$\hat{m}^*$	$\sigma_{m,G} = \frac{1-\gamma}{\Delta}.a_1.\left[1-\alpha.(1-\phi)\right] \geq 0$	$\sigma_{m,F} = \frac{1-\beta}{\beta.\Delta}.a_1.(\mu-\phi) \geq 0$
$\hat{y}^*$	$\sigma_{y,G} = \frac{1-\gamma}{\Delta}.\left[1-\alpha.(1-\phi)\right].(1-a_1.a_2) \geq 0$	$\sigma_{y,F} = \frac{1-\beta}{\beta.\Delta}.\left[(\gamma.(1-\alpha.(1-\phi))-\phi).(1-a_1.a_2)+(1-\alpha).a_1.a_2\right]$
$\hat{q}^{T^*}$	$\sigma_{q^T,G} = \sigma_{D^T,G} \geq 0$	$\sigma_{q^T,F} = \frac{1-\beta}{\beta.\Delta}.\frac{\phi}{\alpha.\mu}.\left[(\mu.(\alpha.\gamma-1)+\gamma.(1-\alpha)).(1-a_1.a_2)+(1-\alpha).a_1.a_2\right]$
$\hat{p}^{NT^*}$	$\sigma_{p^{NT},G} = -\frac{1-\gamma}{\mu.\Delta}.\left[\mu.(1-\phi).(1-a_1.a_2)+\phi.a_1.a_2\right] \leq 0$	$\sigma_{p^{NT},F} = \frac{1-\beta}{\beta.\Delta}.\frac{\mu-\phi}{\alpha.\mu}.\left[(\mu-\gamma).(1-a_1.a_2)-a_1.a_2\right]$

[a] When signaling these multipliers we are assuming Δ to be positive. Otherwise, is easy to obtain the relevant signs.

[b] The values for the tradable good price multipliers are $\sigma_{P,\,p^T} = \sigma_{p^{NT},\,p^T} = 1$ and zero for all the others.

TABLE II

SHORT-RUN MULTIPLIERS IN MATRIX Θ[c]

	$\hat{G}_t$	$\hat{i}_{t-1}$	$\hat{p}_t^T$
$\hat{D}_t^{NT}$	$\theta_{D^{NT},G} = \frac{(1-\gamma).(\mu-1)}{\varphi} \geq 0$	$\theta_{D^{NT},i} = (1-\beta).\frac{\alpha.\gamma}{\varphi}$	$\theta_{D^{NT},p^T} = -\frac{\alpha.\gamma}{\varphi}$
$\hat{D}_t^T$	$\theta_{D^T,G} = \frac{\mu.(1-\gamma)}{\varphi} \geq 0$	$\theta_{D^T,i} = (1-\beta).\frac{\mu-\gamma.(1-\alpha)}{\varphi} \geq 0$	$\theta_{D^T,p^T} = -\frac{\mu-\gamma.(1-\alpha)}{\varphi} \leq 0$
$\hat{F}_t$	$\theta_{F,G} = -\frac{(1-\gamma).\alpha.\mu}{\varphi} \leq 0$	$\theta_{F,i} = -(1-\beta).\frac{\alpha.\mu.\rho}{(\mu-\phi).\varphi} \leq 0$	$\theta_{F,p^T} = \frac{\alpha.\mu.\rho}{(\mu-\phi).\varphi} \geq 0$
$\hat{P}_t$	$\theta_{P,G} = \frac{(1-\alpha).(1-\gamma).(\mu-1)}{\varphi} \geq 0$	$\theta_{P,i} = (1-\beta).\frac{(1-\alpha).(\mu-\gamma)}{\varphi} \geq 0$	$\theta_{P,p^T} = \frac{\alpha.\mu.(1-\gamma)}{\varphi} \geq 0$
$\hat{D}_t$	$\theta_{D,G} = 1+\theta_{C,G}$	$\theta_{D,i} = \theta_{C,i} \geq 0$	$\theta_{D,p^T} = \theta_{C,p^T} \leq 0$
$\hat{C}_t$	$\theta_{C,G} = -\frac{(1-\alpha).(\mu-1)}{\varphi} \leq 0$	$\theta_{D^{NT},i} = (1-\beta).\frac{\alpha.\mu}{\varphi} \geq 0$	$\theta_{D^{NT},p^T} = -\frac{\alpha.\mu}{\varphi} \leq 0$
$\hat{y}_t$	$\theta_{y,G} = \frac{(1-\alpha).(1-\gamma)}{\varphi} \geq 0$	$\theta_{y,i} = -(1-\beta).\frac{\alpha.\mu.[\rho-(\mu-\phi)]}{(\mu-\phi).\varphi}$	$\theta_{y,p^T} = \frac{\alpha.\mu.[\rho-(\mu-\phi)]}{(\mu-\phi).\varphi}$
$\hat{q}_t^T$	0	$\theta_{q^T,i} = -(1-\beta).\frac{\phi}{\mu-\phi} \leq 0$	$\theta_{q^T,p^T} = \frac{\phi}{\mu-\phi} \geq 0$
$\hat{p}_t^T$	$\theta_{p^{NT},G} = \frac{(1-\gamma).(\mu-1)}{\varphi} \geq 0$	$\theta_{p^{NT},i} = (1-\beta).\frac{\mu-\gamma}{\varphi} \geq 0$	$\theta_{p^{NT},p^T} = -\frac{\alpha.\gamma.(\mu-1)}{\varphi}$

[c] $\varphi = |\mathbf{A}|.\mu.(1-\gamma) = (\mu-\gamma)-\alpha.\gamma.(\mu-1) \geq 0$.

TABLE III

SHORT-RUN MULTIPLIERS IN MATRIX $\mathbf{\Omega}^{d}$

	$\hat{F}_{t-1}$	$\hat{C}_{t-1}$
$\hat{D}_t^{NT}$	0	$\omega_{D^{NT},C} = \dfrac{\alpha.\gamma.(1-\gamma)}{\varphi}$
$\hat{D}_t^{T}$	0	$\omega_{D^{T},C} = \dfrac{(1-\gamma).\left[\mu-\gamma.(1-\alpha)\right]}{\varphi} \geq 0$
$\hat{F}_t$	$\omega_{F,F} = \dfrac{1}{\beta} > 0$	$\omega_{F,C} = -\dfrac{\alpha.\mu.(1-\gamma).\rho}{(\mu-\phi).\varphi} \leq 0$
$\hat{P}_t$	0	$\omega_{P,C} = \dfrac{(1-\alpha).(1-\gamma).(\mu-\gamma)}{\varphi} \geq 0$
$\hat{D}_t$	0	$\omega_{D,C} = \omega_{C,C} \geq 0$
$\hat{C}_t$	0	$\omega_{C,C} = \dfrac{\alpha.\mu.(1-\gamma)}{\varphi} \geq 0$
$\hat{y}_t$	0	$\omega_{y,C} = -\dfrac{\alpha.\mu.(1-\gamma).\left[\rho-(\mu-\phi)\right]}{(\mu-\phi).\varphi}$
$\hat{q}_t^{T}$	0	$\omega_{q^{T},C} = -\dfrac{\phi.(1-\gamma)}{\mu-\phi} \leq 0$
$\hat{p}_t^{T}$	0	$\omega_{p^{NT},C} = \dfrac{(1-\gamma).(\mu-\gamma)}{\varphi} \geq 0$

[c] All the other values in this matrix are zero.

TABLE IV

NUMERICAL VALUES FOR THE PARAMETERS

α	β	γ	ϕ	μ	ξ	χ	ε	τ^{NT}
0.6	1/1.05	-3	0.5	1.4	0.2	1	9	0.01145

TABLE V

NUMERICAL VALUES FOR THE STATIC NET FOREIGN ASSETS MULTIPLIERS

Variables	No Entry	Free Entry
$\hat{D}^{NT^*}$	-0.02700	-0.02755
$\hat{D}^{T^*}$	0.039653	0.039796
$\hat{D}^*$	0.012857	0.012990
$\hat{P}^*$	0.026993	0.026663
$\hat{C}^*$	0.012857	0.012990
$\hat{m}^*$	-	0.006705
$\hat{y}^*$	-0.03714	-0.03701
$\hat{q}^{T^*}$	-0.04368	-0.04354
$\hat{p}^{NT^*}$	0.067347	0.066658

TABLE VI

NUMERICAL SIMULATIONS FOR Δ[e]

No.	α	ϕ	γ	ξ	μ	τ^{NT}	min Δ
0	[0.5, 0.7] (0.1)	[0.4, 0.6] (0.1)	[-3.1, -2.9] (0.1)	[0.1, 0.3] (0.1)	[1.3, 1.5] (0.1)	[0.00145, 0.02145] (0.01)	3.310
1	[0.01, 1] (0.5)	[0.01, 1] (0.5)	[0.8, 1] (0.1)	[0.01, 1] (0.5)	[1.01, 1.2] (0.1)	[0.01, 2] (1)	-[f]
2	[0.01, 1] (0.33)	[0.01, 1] (0.33)	[0.8, 1] (0.07)	[0.01, 1] (0.33)	[1.01, 1.2] (0.07)	[0.01, 2] (0.67)	-[f]
3	[0.01, 1] (0.25)	[0.01, 1] (0.25)	[0.8, 1] (0.05)	[0.01, 1] (0.25)	[1.01, 1.2] (0.05)	[0.01, 2] (0.5)	-[f]
4	[0.01, 1] (0.2)	[0.01, 1] (0.2)	[0.8, 1] (0.04)	[0.01, 1] (0.2)	[1.01, 1.2] (0.04)	[0.01, 2] (0.4)	-[f]
5	[0.01, 1] (0.17)	[0.01, 1] (0.17)	[0.8, 1] (0.03)	[0.01, 1] (0.17)	[1.01, 1.2] (0.03)	[0.01, 2] (0.33)	-[f]
6	[0.01, 1] (0.14)	[0.01, 1] (0.14)	[0.8, 1] (0.03)	[0.01, 1] (0.14)	[1.01, 1.2] (0.03)	[0.01, 2] (0.29)	0.150
7	[0.01, 1] (0.125)	[0.01, 1] (0.125)	[0.8, 1] (0.025)	[0.01, 1] (0.125)	[1.01, 1.2] (0.025)	[0.01, 2] (0.25)	0.150[g]
8	[0.01, 1] (0.11)	[0.01, 1] (0.11)	[0.8, 1] (0.01)	[0.01, 1] (0.11)	[1.01, 1.2] (0.01)	[0.01, 2] (0.22)	0.150[g]
9	[0.01, 1] (0.1)	[0.01, 1] (0.1)	[0.8, 1] (0.01)	[0.01, 1] (0.1)	[1.01, 1.2] (0.01)	[0.01, 2] (0.2)	0.150[g]

[e] Values in squared brackets represent the extremes of the search interval. Values in round brackets represent the length of the search step.

[f] No economically plausible equilibrium exists for these values.

[g] The minimum for Δ in this simulation was at least as big as the one obtained in the previous simulation.