Monopolistic Competition and the Dependent Economy Model

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Abstract

This paper explores the consequences of introducing a monopolistic competition in a two-sector open economy model. The effects of fiscal and technological shocks are simulated. First, unlike the perfectly competitive framework, the present model is consistent with the saving-investment correlations found in the data. Second, the degree of competition observed in non traded markets matters in determining the current account and investment responses to fiscal and technological shocks. Third, simulations show that the perfectly competitive two-sector model is too restrictive when investigating the relationship between the relative price of non traded goods and real factors like fiscal policies and productivity disturbances.

Keywords: Monopolistic Competition; Inflation; Fiscal Policy; Productivity.
JEL Classification: E20; E62; F31; F41.

Résumé

Cet article développe un modèle d'équilibre général dynamique à deux secteurs avec concurrence monopolistique sur le marché des biens non échangeables. Les effets des chocs de dépenses publiques et de productivité sont simulés numériquement. Conformément aux résultats empiriques, le modèle génère des corrélations positives entre épargne et investissement. En outre, le degré d'intensité concurrentielle sur le marché des biens non échangeables affecte les réactions du solde courant et de l'investissement après un choc de demande ou d'offre. Enfin, les résultats numériques montrent que le modèle à deux secteurs en concurrence parfaite fournit un cadre théorique trop restrictif pour étudier le comportement du prix relatif des biens non échangeables.

Mots-clés : Concurrence Imparfaite; Inflation; Dépenses Publiques; Productivité.
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1 Introduction

Recent years have witnessed the relevance of the imperfect competition as a promising framework for the analysis of disturbances in international macroeconomic models. Sen [2005] explores welfare effects of a tariff in a two-sector model and shows that, relaxing the perfect competition assumption in the traded (non traded) sector leads protection policy to be welfare-improving (-reducing). Heijdra and Ligthart [2006] and Coto-Martinez and Dixon [2003] demonstrate that the fiscal multiplier is increasing with the degree of imperfection competition. Ubide [1999] finds that the introduction of imperfect competition improves the performance of the real business cycle model to match empirical regularities.

This paper extends the two-sector continuous time model of Turnovsky and Sen [1995] by introducing monopolistic competition in the non traded goods sector.[1] More specially, the market structure in that sector includes Dixit and Stiglitz [1977] preferences and endogenous markups which depend on the composition of aggregate demand for non traded goods. The starting point for this paper is the growing evidence that (i) goods markets appear to be less competitive than is commonly supposed, and (ii) foreign competition lowers the distortions from imperfect competition by reducing markups. Christopoulou and Vermeulen [2008] provide markup estimates for manufacturing and services industries for a group of eight Euro area countries. Their estimates report that markups for services tend to be higher than those observed in manufacturing industries, averaging 1.56 and 1.18 respectively.[2]

The model is calibrated with standard parameters values to match OECD data and is potentially useful in explaining empirical regularities. First off, the introduction of a monopolistic non traded sector in a small open economy facing perfect capital mobility seems to provide a convincing explanation to resolve the Feldstein-Horioka puzzle (Feldstein and Horioka [1980]). Indeed, by introducing some form of imperfect competition, the model outperforms the Walrasian two-sector framework in replicating the saving-investment correlations of the OECD data, without relaxing the assumption that financial assets are perfectly mobile internationally. Second, simulations show that the monopolistically two-sector model offers a richer framework to analyze the effects fiscal and technological shocks on the relative price of non traded goods. Indeed, the paper emphasizes the importance of the endogenous response of the markup in transmitting demand and supply disturbances to the relative price. Unlike the competitive model, the relative price of non traded goods responds to fiscal shocks in the long-run. Furthermore, numerical results indicate that a part of the relative price appreciation triggered by productivity growth differentials can be attributed to the endogenous variations in markups. This result puts into perspective the basic prediction of the usual perfectly competitive Balassa-Samuelson model (Balassa [1964] and Samuelson [1964]) that the relative price is entirely supply-side. Third, the responses of the current account and investment to fiscal and technological shocks may be

[1] Coto-Martinez and Dixon [2003] include the monopolistic competition hypothesis in the Turnovsky and Sen's [1995] model as well. However, their framework and purpose depart from ours in two points. First, the underlying assumptions are quite different. Unlike the present model, Coto-Martinez and Dixon introduce sunk costs in the non traded market and a labor-leisure trade-off. Second, most of Coto-Martinez and Dixon's attention is devoted to effects of fiscal policy with the purpose to draw out the differences between free entry and fixed number of firms situations. In contrast, this framework analyzes the model's responses to both supply and fiscal shocks.

[2] Moreover, markups differ across countries. Estimates for services (manufacturing) ranges from 1.26 (1.13) for France (Netherlands) to 1.87 (1.23) in Italy (Italy).

reversed in the monopolistically competitive model compared to those derived in the perfectly competitive framework. In particular, results are quite dependent from the degree of competition and indicate that it may be useful to depart from the assumption of perfect competition when analyzing the effects of fiscal policies and productivity disturbances on the current account and investment variables.

The structure of the rest of the paper is as follows. Section 2 presents the monopolistically competitive two-sector small open economy. Section 3 is devoted to numerical simulations and studies the effects of fiscal and technological shocks. Conclusions are presented in Section 4.

2 The Framework

The small open economy produces two types of goods: one is non traded and, the other is traded and serves as numeraire. The production of the traded good can be consumed domestically or exported, while the non traded good may be domestically consumed or used for physical capital investment.[3] The traded sector is perfectly competitive with firms producing a homogenous good. By contrast, the non traded sector is characterized by the presence of a continuum of monopolistically competitive firms producing a specific good indexed by $z \in [0, 1]$.

2.1 Households and Government

The representative household supplies inelastically his labor endowment, normalized to one for analytical convenience, $L = 1$, and maximizes a lifetime utility function of the form

$$\int_0^\infty u\left(c\right)\ e^{-\beta t}\,\mathrm{d}t, \tag{1}$$

with

$$c = c\left(c^T, c^N\right), \qquad \text{and} \qquad c^N = \left(\int_0^1 c^N\left(z\right)^{\frac{\rho-1}{\rho}}\mathrm{d}z\right)^{\frac{\rho}{\rho-1}}, \tag{2}$$

where β is the consumer's discount rate, $\beta \in [0, 1]$, and $u(.)$ is strictly concave. The composite consumption good c is an aggregate of traded and non traded consumptions (c^T and c^N respectively), while preferences over the non traded goods are described by the Dixit and Stiglitz [1977] aggregator function, ρ being the substitution elasticity between the varieties ($\rho > 1$). The household decision problem is solved by the means of three-stage budgeting.

In the first stage, the consumer chooses the time profile for aggregate consumption to maximize the utility function (1) subject to its following budget constraint:

$$\dot{a} = r^* a + \Pi + w - \pi^c c - T^L, \tag{3}$$

where a is the real financial wealth, r^* is the exogenous real world interest rate, Π is the household's profit income, w is the real wage rate, π^c is the given consumption-based price

[3]Brock and Turnovsky [1994] develop a model that incorporates both types of capital goods (traded and non traded), and demonstrate that dynamics of the core model depends only upon the relative intensities of the non traded investment good. In addition, empirical researches point out that investments have a very significant nontradable component. Burstein et al. [2004] estimate this share within the 0.46-0.71 range, averaging 0.59.

index and T^L denotes lump-sum taxes paid to the government.[4] Letting λ be the shadow value of wealth measured in terms of traded bonds, the first-order conditions associated with the household's optimal dynamic plans are

$$\begin{aligned} u_c &= \pi^c \lambda, \qquad (4a) \\ \dot{\lambda} &= \lambda \left(\beta - r^* \right), \qquad (4b) \end{aligned}$$

and the transversality condition $\lim_{t \to \infty} \lambda a e^{-\beta t} = 0$. The optimality condition (4a) equates the marginal utility of consumption to the shadow value of wealth measured in terms of the consumption-price index. With a constant rate of time preference and an exogenous interest rate, from equation (4b) we impose $\beta = r^*$ in order to ensure the existence of a well-behaved steady-state. This standard assumption implies that the marginal utility of wealth must remain constant over time and is always at its steady state level, $\bar{\lambda}$.

In the second stage, total expenditure on consumption is divided over traded and non traded goods according to

$$c^T = (1 - \alpha) \pi^c c, \qquad \text{and} \qquad p c^N = \alpha \pi^c c, \tag{5}$$

where α is the share of consumption expenditure spent on non traded goods ($0 < \alpha < 1$), and p is the relative price of the composite non traded good (see below). Combining (4a) and (5), c^T and c^N may be solved as functions of $\bar{\lambda}$ and p which gives the Frisch demand curves:

$$c^T = c^T \left(\bar{\lambda}, p \right), \qquad \text{and} \qquad c^N = c^N \left(\bar{\lambda}, p \right), \tag{6}$$

with $c^T_{\bar{\lambda}} < 0$, $c^T_p \lesseqgtr 0$, $c^N_{\bar{\lambda}} < 0$ and $c^N_p < 0$.[5] An higher shadow value of wealth induces domestic households to increase savings and to reduce consumption of both goods. An increase in the relative price of the non traded good leads to a decline in its consumption, while the sign of c^T_p depends on the interplay between the intertemporal elasticity of substitution (σ) and the intratemporal elasticity of substitution between traded and non traded goods (ϕ).

In the third stage, total non traded consumption is allocated between varieties as follows,

$$c^N(z) = \left(\frac{p(z)}{p} \right)^{-\rho} c^N, \tag{7}$$

where $p(z)$ is the relative price of the non traded good z and p stands for the non traded good relative price index in the form $p = \left(\int_0^1 p(z)^{1-\rho} \mathrm{d}z \right)^{\frac{1}{1-\rho}}$.

Finally, the domestic government levies lump-sum taxes T^L to finance real expenditures g^T and $g^N(z)$ and follows a balanced budget policy given by:

$$g^T + \int_0^1 p(z) g^N(z) \mathrm{d}z = T^L. \tag{8}$$

[4] In this setup subindexes denote the variable with respect to which the derivative is taken, while overdots indicate time derivatives.

[5] Expressions of short-run solutions derived in the Section 2 are reported in Appendix A.

2.2 Elasticity of Demand and Markup

The demand faced by non traded firm z, denoted by $Y^N(z)$, has two components: private consumption, $c^N(z)$, and public spending, $g^N(z)$. The (absolute value of the) elasticity of the demand curve for good z, noted $\eta(z)$, is the weighted average of individual elasticities. Government expenditure $g^N(z)$ being exogenous, $\eta(z)$ simplifies to:

$$\eta(z) = \rho \, \frac{c^N(z)}{Y^N(z)} \equiv \frac{\mu(z)}{\mu(z)-1}, \tag{9}$$

where the (absolute value of the) price-elasticity of $c^N(z)$ is ρ and $\mu(z)$ represents the firm's markup. The second equality in (9) implicity defines the markup as functions of the degree of substitutability of non traded goods, ρ, and the composition of the demand faced by producers present in the domestic market. The higher is ρ, the better substitutes the varieties are for each other and the closer is the model to the perfectly competitive one. Moreover, the markup varies endogenously in response to exogenous shocks that affect the composition of demand, like expansionary fiscal policies (see Gali [1994]). Furthermore, for the firms' problem to have an interior solution, we need to assume that $\eta(z) > 1$, condition which ensures that the markup is greater than unity. Inserting solution for c^N, equation (6), into (9) leads to:

$$\mu(z) = \mu\left(\bar{\lambda}, p(z), g^N(z)\right), \tag{10}$$

where $\mu_{\bar{\lambda}}$, $\mu_{p(z)}$ and $\mu_{g^N(z)}$ are positive. An rise in $\bar{\lambda}$ or $p(z)$ lowers the non traded consumption $c^N(z)$. As a consequence, the share of private consumption in total demand for non traded good decreases, and the monopolistic firm is inclined to charge a higher markup as a greater part of aggregate demand will not react to a relative price appreciation. An increase in $g^N(z)$ reduces the share of consumption in total demand for non traded good z. As a result, the elasticity $\eta(z)$ falls and the equilibrium markup rises.

2.3 Firms

Domestic firms in each sector rent capital (K) and hire labor (L) to produce output (Y) employing neoclassical production functions which feature constant returns to scale. Capital and labor clearing conditions write as follows

$$K^T + \int_0^1 K^N(z)\mathrm{d}z = K, \qquad \text{and} \qquad L^T + \int_0^1 L^N(z)\mathrm{d}z = 1. \tag{11}$$

Capital and labor can move freely between sectors and attract the same rental rates in both sectors, ω_K and ω_L respectively.

2.3.1 Traded sector

Output in the traded sector, Y^T is obtained according to the technology $A^T F\left(K^T, L^T\right)$, where A^T, K^T and L^T denote productivity shift, capital and labor used in that sector respectively. Profit maximization in the traded sector implies that the equilibrium factor prices are

$$\omega_K = A^T f_k\left(k^T\right), \tag{12a}$$

$$\omega_L = A^T\left[f\left(k^T\right) - k^T f_k\left(k^T\right)\right], \tag{12b}$$

where the production function and marginal products are expressed in labor intensive form, i.e. $k^T = K^T/L^T$, $f\left(k^T\right) = F\left(K^T, L^T\right)/L^T$, and $f_k = \partial F/\partial K^T$. The constant returns to scale hypothesis drives down profits to zero in the traded sector ($\Pi^T = 0$).

2.3.2 Non Traded sector

Similarly, in the non traded sector, each monopolistic firm produces output $Y^N(z)$ subject to $Y^N(z) = A^N H\left(K^N(z), L^N(z)\right)$, where $K^N(z)$ and $L^N(z)$ represent the capital and labor used for the production of variety z and A^N is a common total factor productivity. The non traded firm z chooses paths for $K^N(z)$ and $L^N(z)$ in order to maximize the profit

$$\Pi^N(z) = p(z)A^N H\left(K^N(z), L^N(z)\right) - \omega_L L^N(z) - \omega_K K^N(z), \tag{13a}$$

$$\text{s.t.} \quad Y^N(z) = c^N(z) + g^N(z) + I(z), \quad \text{and} \quad c^N(z) = \left(\frac{p(z)}{p}\right)^{-\rho} c^N \tag{13b}$$

where the first constraint describes the non traded goods market clearing condition. The first-order conditions for this optimization problem are

$$\mu(z)\,\omega_K = p(z)A^N h_k\left(k^N(z)\right), \tag{14a}$$

$$\mu(z)\,\omega_L = p(z)A^N\left[h\left(k^N(z)\right) - k^N(z)h_k\left(k^N(z)\right)\right], \tag{14b}$$

where $k^N(z) = K^N(z)/L^N(z)$ denotes the capital-labor ratio for non traded firm z. Profit maximization in that sector introduces a wedge between marginal product of each factor and its rental rate. Making use of their market power, monopolistic firms gain profits in reducing output and factors demands, and, the marginal products turn to be higher than rental rates. In addition, profits are positive, $\Pi^N(z) > 0$.

2.4 Portfolio Investments

There are two assets available in the economy.[6] First, foreign bonds b, denominated in terms of traded goods, pay the exogenous world interest rate r^*. And second, non traded capital goods are accumulated without depreciation for simplicity, according to $\dot{K}(z) = I(z)$, where $I(z)$ is the investment flow. The portfolio investor chooses paths for $I(z)$ and $K(z)$ to maximize the present value of cash flows $V^K(z)$

$$V^K(z) = \int_t^\infty \left[\frac{\omega^K}{p(z)}K(z)_\tau - I(z)_\tau\right] e^{-\int_t^\tau r_K(z)_s ds}\mathrm{d}\tau, \tag{15}$$

subject to $\dot{K}(z) = I(z)$ where $\int_t^\tau r_K(z)_s \mathrm{d}s$ is the discount factor. The investor optimum is fully characterized by:

$$p(z)r_K(z) = \omega_K, \tag{16}$$

where $r_K(z)$ is the rate of return on capital $K(z)$. Portfolio investors are indifferent between traded bonds and non traded capital assets if and only if their rates of return (expressed in the same units) equalize. Using (14a) and (16), the no-arbitrage condition immediately follows:

$$r^* = \frac{A^N h_k\left(k^N(z)\right)}{\mu(z)} + \frac{\dot{p}(z)}{p(z)}. \tag{17}$$

[6] This section draws heavily on Bettendorf and Heijdra [2006].

2.5 Macroeconomic Equilibrium

As is conventional in the literature, we consider the symmetric equilibrium in which all non traded producers fix the same markup, $\mu(z) = \mu$, charge the same price, $p(z) = p$, implying that $k^N(z) = k^N$ for all z. The equilibrium satisfies (4a), (11) and (17) and the following equations:

$$\mu A^T f_k = p A^N h_k, \tag{18a}$$

$$\mu A^T \left(f - k^T f_k\right) = p A^N \left(h - k^N h_k\right), \tag{18b}$$

$$\dot{K} = Y^N - c^N - g^N, \tag{18c}$$

$$\dot{b} = r^* b + Y^T - c^T - g^T. \tag{18d}$$

Equations (18a) and (18b) equate the marginal physical products of capital and labor in the two sectors. Equation (18c) is the non traded good market clearing condition. Equation (18d) which describes the country's current account, is obtained by combining (3), (8), (18c) and (17).[7]

The complete macroeconomic equilibrium can be performed by computing short-run static solutions for sectoral capital intensities, labor demands and outputs. Static optimality conditions (18a) and (18b) may be solved for capital intensities ratios in the form:

$$k^T = k^T(p), \qquad \text{and} \qquad k^N = k^N(p). \tag{19}$$

The signs of (19) depend upon relative capital intensities, that is, $k_p^T > 0$ and $k_p^N > 0$ when $k^T > k^N$.[8] Substituting (19) into constraints (11) and production functions, labor demands and outputs may be derived as follows

$$L^T = L^T(K,p), \qquad \text{and} \qquad L^N = L^N(K,p), \tag{20a}$$

$$Y^T = Y^T(K,p), \qquad \text{and} \qquad Y^N = Y^N(K,p), \tag{20b}$$

with L_K^T, Y_K^T, L_K^N, Y_K^N depending on wether $k^T \gtrless k^N$, and, $L_p^T = -L_p^N < 0$, and $Y_p^T < 0$, $Y_p^N > 0$. A higher capital stock increases (decreases) labor and output in the more capital (labor) intensive sector (Rybczynski Theorem). A rise in p shifts labor from the traded to the non traded sector, causing the output of that sector to grow, at the detriment of Y^T.

2.6 Equilibrium Dynamics

Linearizing equations (17) and (18c) around the steady-state (denoted by tilde) results in

$$\begin{pmatrix} \dot{K} \\ \dot{p} \end{pmatrix} = \begin{pmatrix} Y_K^N & Y_p^N - c_p^N \\ 0 & -(pA^N h_{kk} k_p^N)/\mu \end{pmatrix} \begin{pmatrix} K(t) - \tilde{K} \\ p(t) - \tilde{p} \end{pmatrix}. \tag{21}$$

Equation (21) describes a dynamic system characterized by one negative eigenvalue, ν_1, and one positive eigenvalue, ν_2, irrespectively of the sectoral capital intensities. Since the system features one predetermined state variable, K, and one jump variable, p, the dynamics are saddle-path

[7] The financial wealth a equals the sum of domestic capital stock and traded bonds holding, $a = b + pK$.

[8] As we wish to keep the model as tractable as possible, the derivatives of short-run solutions for k^i, L^i and Y^i, $i = T, N$, are evaluated in the neighborhood of an initial steady-state where $g^N = 0$.

stable. Starting from an initial capital stock K_0, the stable solutions take the following form

$$K(t) = \tilde{K} + \left(K_0 - \tilde{K}\right) e^{\nu_1 t}, \tag{22a}$$

$$p(t) = \tilde{p} + \omega_1 \left(K_0 - \tilde{K}\right) e^{\nu_1 t}, \tag{22b}$$

where $(1, \omega_1)$ is the eigenvector associated with ν_1. As is well known from two-sector models, the qualitative equilibrium dynamics depend critically upon the relative capital intensities. In particular, the transitional path of $p(t)$ degenerates if $k^T > k^N$ and $p(t) = \tilde{p}$, $\forall t$.[9] In the alternative situation, $k^N > k^T$, the relative price features transitional dynamics.

Linearizing (18d) around the steady state, and inserting the stable solutions for $K(t)$ and $p(t)$ gives the stable solution for $b(t)$,

$$b(t) = \tilde{b} + \Omega \ (K_0 - \tilde{K}) e^{\nu_1 t}, \tag{23}$$

consistent with the intertemporal solvency condition $(b_0 - \tilde{b}) = \Omega \ (K_0 - \tilde{K})$. Given the initial stocks of physical capital and foreign bonds, K_0 and b_0, the intertemporal budget constraint describes the trade-off between accumulations of traded bonds and capital. Following the same steps as before, the stable time path followed by the financial wealth $a(t)$ is given by:

$$a(t) = \tilde{a} + \Phi \ (K_0 - \tilde{K}) e^{\nu_1 t}. \tag{24}$$

Equation (24) describes the relationship between savings and investment during the transition.

In comparison to the Turnovsky and Sen's [1995] competitive model, the expression Ω takes a more general form since relaxing the perfect competition assumption makes the international bonds accumulation dependent on the variation in profits. The general form of Ω is given by

$$\Omega = -\tilde{p} - \omega_1 \tilde{K} + \Phi. \tag{25}$$

Expression (25) highlights that three possibly offsetting effects interact on the dynamics of internationally traded bonds along the stable adjustment. First, the negative smoothing effect, reflected by the term $-\tilde{p}$, emphasizes the role of consumption smoothing on the current account. Rather than reduce their consumption, the agents choose to finance investment by borrowing from abroad such that the current account worsens. Second, the relative price adjustment effect $(-\omega_1 \tilde{K})$ comes from the transitional dynamics of $p(t)$ toward the steady-state. This effect encourages current account surpluses as the economy accumulates capital. And finally, the savings effect, measured by Φ, can be split into two forces: the real interest rate and profit components. The real interest rate force comes from the relative price transitional dynamics toward the steady-state. While the capital stock accumulates, the relative price depreciates gradually, which provides an incentive for consumers to substitute current consumption for future consumption as the real interest rate in terms of consumption goods exceeds the world real rate, $r^c > r^*$ (Dornbusch [1983]). Thus, real consumption purchases fall and the savings flow rises. The last component captures the variation in profits, caused by investment, on the current account and is no longer obtained in a perfectly competitive model. Using standard methods, the stable path followed by profits is $\Pi(t) = \tilde{\Pi} + \Upsilon \ (K_0 - \tilde{K}) e^{\nu_1 t}$, where Υ describes

[9] The expressions of ν_1 , ν_2 and ω_1, and, of the terms Ω, Φ and Υ (see below) are documented in Appendix B.

the relationship between profits and capital accumulation along the stable path. If $\Upsilon > 0$, when the economy accumulates capital ($K_0 < \tilde{K}$), the profit flow is above its steady state value and, in order to offset the reduction in future income due to the decline in profits, agents are going to invest their high initial profit in the international market bonds.

In the case $k^T > k^N$, as dynamics for $p(t)$ are flat ($\omega_1 = 0$), the relative price adjustment effect and the real interest component of the savings effect become ineffective. Subsequently, equation (25) reduces to $\Omega = -\tilde{p} + \Upsilon < 0$, with $\Upsilon = \Phi > 0$. As $\Omega < 0$, the smoothing effect is large enough to compensate the profit effect, current account and investment are thus negatively related. Moreover, Φ being positive, savings and investment flows are positively correlated. Relaxing the perfect competition hypothesis allows to generate positive saving-investment correlations consistent with the perfect access to financial capital markets assumption such as Feldstein and Horioka [1980] find in their well-known empirical work.[10]

When $k^N > k^T$, the signs of Ω and Φ are ambiguous and point out the influence of preferences parameters in determining the current account-investment and savings-investment relationships. According to empirical studies which present evidence that current account is negatively linked with investment flow (Glick and Rogoff [1995] and İşcan [2000]), one may expect Ω to be negative implying that the smoothing effect is large enough to outweigh the sum of the relative price adjustment and the savings effects.

2.7 The Steady-State

The steady-state is reached when $\dot{p}, \dot{K}, \dot{b} = 0$ and is defined by the following equations:

$$A^N h_k[k^N(\tilde{p})] = \mu\left(\bar{\lambda}, \tilde{p}, g^N\right) r^*, \tag{26a}$$

$$Y^N(\tilde{K}, \tilde{p}) - c^N(\bar{\lambda}, \tilde{p}) - g^N = 0, \tag{26b}$$

$$r^*\tilde{b} + Y^T(\tilde{K}, \tilde{p}) - c^T(\bar{\lambda}, \tilde{p}) - g^T = 0, \tag{26c}$$

$$(b_0 - \tilde{b}) = \Omega\,(K_0 - \tilde{K}). \tag{26d}$$

The steady-state equilibrium jointly determine $\tilde{p}$, $\tilde{K}$, $\tilde{b}$ and $\bar{\lambda}$. Equation (26a) entails that the marginal physical product of capital in the non traded sector ties the world interest rate. From equation (26b) it follows that the long-run investment is zero: the non traded output equals the demand. Equation (26c) asserts that in steady-state, the current account balance must be zero. Finally, the nation's intertemporal budget constraint (26d) implies that the steady-state depends on profits, that is, the existence of a monopolistic competition affects the relationship between capital accumulation and the balance of payments.

The system (26) describing a two-sector monopolistic model cannot be solved recursively as in the competitive case. In the latter situation, the no-arbitrage condition at the steady-state writes as $A^N h_k[k^N(\tilde{p})] = r^*$. The relative price is thus totally fixed by supply-side consideration, i.e. demand shocks leave unchanged its steady-state value. This result stands in sharp contrast to our monopolistic model which breaks down the dichotomy between supply and demand sides of the economy. In particular, the relative price of the non traded good is affected by fiscal policies

[10] The treatment of physical capital assets, K, as being non traded does not involve any loss of generality in examining the Feldstein and Horioka's puzzle. It is worth noting that financial capital assets, b, are internationally mobile implying that the economy features a perfect financial integration degree.

and preferences shifts that impinge on the markup. The existence of a monopolistic competition introduces additional features into the analysis of fiscal expansions since movements in the relative price and the existence of profits have the potential to alter production, consumption decisions in a manner that is absent in a competitive model.

3 Quantitative Analysis

The model is calibrated for a plausible set of utility and production parameters in order to be consistent with data of developing countries. We assume that the instantaneous utility function exhibits constant relative risk aversion $u(c) = \frac{1}{1-\frac{1}{\sigma}} c^{1-\frac{1}{\sigma}}$, where σ, the intertemporal elasticity of substitution, is set equal to 0.7, value consistent with the empirical estimates (Cashin and McDermott [2003]). Households maximize a C.E.S. aggregate consumption function given by $c\left(c^T, c^N\right) = (\varphi^{\frac{1}{\phi}} \left(c^T\right)^{\frac{\phi-1}{\phi}} + (1-\varphi)^{\frac{1}{\phi}} \left(c^N\right)^{\frac{\phi-1}{\phi}})^{\frac{\phi}{\phi-1}}$ where φ parameterizes the relative importance of traded and non traded goods in the overall consumption bundle, and ϕ is the intratemporal elasticity of substitution. The parameter φ is computed so that $\alpha \approx 0.45$ as in Stockman and Tesar [1995]. Therefore, we assign φ to 0.5. The intratemporal elasticity of substitution ϕ is set to 1.50 implying that the consumptions of traded and non traded are substitutes (i.e. $c_p^T > 0$). Moreover, we complete a sensitivity analysis on ϕ to check the robustness of the results to this parameter. The benchmark value for the elasticity of substitution between non traded varieties (ρ) is chosen in order to obtain a markup value close to the empirical estimates provided by Christopoulou and Vermeulen [2008]. We also perform a sensitivity analysis on ρ.[11] The two sectors possess Cobb-Douglas intensive production functions: $f\left(k^T\right) = \left(k^T\right)^{\theta^T}$ and $h\left(k^N\right) = \left(k^N\right)^{\theta^N}$ where θ^T and θ^N indicate the degrees of capital intensity in the traded and non traded sectors respectively. When $k^T > k^N$ ($k^N > k^T$), the values of θ^T and θ^N are set to 0.45 (0.35) and 0.35 (0.45) respectively. These values correspond roughly to sectoral capital shares estimated by Kakkar [2003]. Following Morshed and Turnovsky [2004], productivity parameters A^T and A^N are fixed to 1.5 and 1 respectively. The value of the world interest rate is chosen to be 6% which is close to the average real rate of return to capital in the U.S. over the period 1948-1996 estimated by King and Rebelo [1999]. The values for g^T and g^N are set to obtain data consistent government expenditure-GDP ratios and to reflect the tendency for public spending to fall disproportionately on non traded goods.

Table 3 in Appendix C reports ratios describing the benchmark steady-state. The monopolistic equilibriums are reasonable characterization of a small open economy having a significant non traded goods sector. In particular, benchmark monopolistic models predict savings-investment correlations that are plausible with the empirical evidence: 0.75 when $k^T > k^N$ and 0.20 when $k^N > k^T$. Considering the wide range of observed correlations in OECD countries, from 0.10 to 0.97, Table 1 reports the findings of a sensitivity analysis performed for different values of ρ along the row and different values for ϕ across the column[12].

[11] Despite being a preference parameter, ρ parameterizes the degree of competition in the non traded goods market as well. In general, it is equivalent to vary competition by altering the numbers of firms or by varying the degree of substitution between goods (Jonsson [2007]). Modify ρ being more tractable than allow for entry/exit of firms, the former approach is chosen to illustrate changes in the degree of competition in goods markets.

[12] Simulations with $\phi \in [0.3\ ; 2.0]$ illustrate the cases $\phi > \sigma$, $\phi = \sigma$ and $\phi < \sigma$. The parameter ρ ranges different degrees of competition from monopolistic competition ($\rho = 5$) to competitive non traded markets ($\rho = 20$).

Table 1: Sensitivity Analysis to the Saving-Investment Correlation

	Monopolistic Competition ($\rho =$)											PC
	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	
$\phi =$	$k^T > k^N$											
2.00	0.87	0.71	0.61	0.54	0.48	0.43	0.40	0.37	0.34	0.32	0.30	0
1.50	0.68	0.59	0.52	0.46	0.42	0.38	0.35	0.33	0.30	0.28	0.27	0
1.00	0.60	0.53	0.47	0.42	0.38	0.35	0.33	0.30	0.28	0.26	0.25	0
0.70	0.57	0.50	0.45	0.41	0.37	0.34	0.31	0.29	0.27	0.26	0.24	0
0.30	0.55	0.48	0.43	0.39	0.36	0.33	0.30	0.28	0.27	0.25	0.24	0
	$k^N > k^T$											
2.00	0.16	0.10	0.06	0.03	0.01	-0.01	-0.03	-0.04	-0.05	-0.06	-0.07	-0.19
1.50	0.13	0.09	0.05	0.02	0.00	-0.01	-0.03	-0.04	-0.05	-0.06	-0.07	-0.19
1.00	0.12	0.08	0.04	0.02	0.00	-0.02	-0.03	-0.04	-0.05	-0.06	-0.07	-0.19
0.70	0.11	0.07	0.04	0.02	0.00	-0.02	-0.03	-0.04	-0.05	-0.06	-0.07	-0.19
0.30	0.11	0.07	0.04	0.01	0.00	-0.02	-0.03	-0.04	-0.05	-0.06	-0.07	-0.19

Notes: PC = Perfect Competition.

As shown in Turnovsky and Sen [1995], the savings-investment correlation in the competitive model hinges on relative sectoral capital intensities, i.e. the correlation is zero when $k^T > k^N$ and is theoretically ambiguous in the alternative situation, $k^N > k^T$. Simulations results reveal that in the latter case, the correlation is negative (-0.19) and insensitive to the intratemporal elasticity of substitution. This negative correlation is contrary to the empirical evidence in Baxter and Crucini [1993], Ubide [1999] and Obstfeld and Rogoff [2000]. In contrast, the monopolistic competition helps the model to replicate positive savings-investment correlations found in data. Indeed, when $k^N > k^T$, correlation coefficients remain in the positive range found in the data for $\rho < 5.5$. In the situation $k^T > k^N$ high savings-investment correlations are easily reproduced under a wide variety of preferences parameters. Especially, if the market degree of competition is weak ($\rho \leq 6.5$), even small values of ϕ generate realistic correlations of 0.40 or more. The main finding from Table 1 is that the monopolistic model generates realistic savings-investment correlations for plausible parameters configurations and irrespectively of the sectoral capital intensities. The existence of a monopolistic non traded goods sector that ensures the existence of positive profits provides an explanation for the high empirical saving-correlations without relaxing the assumption of strongly international mobile financial capital.

We investigate now the response of the model to demand and supply shocks. Permanent rises in g^T and g^N are calibrated in order to simulate increases in the ratio g/Y of 3 points. Technological shocks are treated as increases in A^T and A^N of 4% and 2% respectively.

3.1 Demand Shocks

The steady-state deviations to public demand shocks are reported in Table 4 in Appendix C. In the model version with perfect competition and irrespective of the sectoral capital intensities, fiscal policies induce a negative wealth effect (i.e. $\bar{\lambda}$ increases), arising from the higher taxes necessary to finance the higher government spending. Consequently, the private consumption is crowded out. In the monopolistically model, this is only a partial effect. In addition, changes in the level of government purchases appreciate the relative price of non traded good which in turn raises the consumer price index and magnifies the fall in consumption. Departing from the perfect competition assumption makes the relative price of non traded good dependent of demand shifts. Irrespective of the good on which the rise in public purchases falls, an increase in government spending alter the composition of non traded demand in favor of its public component since c^N is reduced. As a greater part of aggregate demand does not react to relative price changes, monopolistic firms are encouraged to set higher markup and price.

From (9) and (10), straightforward calculation shows that an increase in g^N induces two positive effects on the markup. First, it modifies directly the composition of aggregate non traded demand by rising the share of public consumption and therefore the markup. And second, the private consumption c^N is reduced after the fiscal shock falling on g^N through the negative wealth effect, which as a consequence entails a higher markup. Comparatively, a rise in g^T improves the markup only through the wealth effect. As a result, relative price responses to traded government expenditures shocks are smaller compared to fiscal expansions falling on g^N. In the latter case, increasing the ratio g/Y of 3 points of GDP generates relative price appreciation of 2.6% (3.4%) when $k^T > k^N$ ($k^N > k^T$), whereas rises in g^T induce soften responses: 0.5% (0.8%) when $k^T > k^N$ ($k^N > k^T$). These numerical results are consistent with the empirical researches which range the appreciation following an increase of three percentage points in the share of government expenditure between 1.2% (Strauss [1999]) and 4.5%-6% for De Gregorio et al. [1994].

The comparison of the steady-state effects on investment and current account between the perfectly and monopolistically competitive models is particularly striking. Table 4 indicates that for the benchmark case ($\phi = 1.5$ and $\rho = 4.5$) the net effects on capital stock and net foreign assets position may be reversed in the monopolistically competitive model compared to those derived in the perfectly competitive framework. In particular, when $k^N > k^T$ ($k^T > k^N$), an increase in g^N (g^T) in the monopolistically competitive model involves a reduction in $\tilde{K}$ and an improvement in $\tilde{b}$ while $\tilde{K}$ rises and $\tilde{b}$ falls in the Walrasian framework. To explore how sensitive the comparison between the two models is to the benchmark parameter values, Table 5 in Appendix C examines the role played by the elasticities ρ and ϕ in determining the responses of K and b to fiscal shocks. In the case of a rise in g^N when $k^N > k^T$, the steady-state changes in capital stock and net foreign assets position are qualitatively insensitive to variations in ρ and ϕ, only the strength of responses are affected: the reduction in $\tilde{K}$ is moderated significantly with declines in ϕ and increases in ρ for instance. In contrast, the long-run effects after a fiscal policy falling on g^T when $k^T > k^N$ are highly sensitive to both parameters. However, for a large set of values of tastes parameters, the responses of current account and investment are qualitatively similar between the monopolistically and the perfectly competitive models.

In addition, introducing the monopolistic competition into the analysis affects substantially the strengths of the current account and investment responses to fiscal shocks, especially those falling on g^N(when $k^T > k^N$, $\mathrm{d}\tilde{K} = -5.1\%$ and $\mathrm{d}\tilde{b} = 14.1\%$ in the monopolistically competitive model, compared to $\mathrm{d}\tilde{K} = -0.8\%$ and $\mathrm{d}\tilde{b} = 0.9\%$ in the perfectly competitive one). More precisely, the monopolistic model highlights the crucial role of intratemporal effects in determining the direction and the strength of current account and investment reactions. In response to a relative price appreciation, intratemporal effects play through a combination of a change in allocation of factors between the two sectors of production and a change in the distribution of real expense between traded and non traded consumptions. By emphasizing the influence of intratemporal effects, our framework points out the importance of relative price movements as an additional channel for transmitting fiscal policy shock to production and consumption decisions, and, ultimately to current account and investment. Recent empirical works on the intertemporal current account approach (see Bergin and Sheffrin [2000]) find evidence in favor of the two-good models since allowing for real exchange rates changes improve the fit of intertemporal models of current account.

3.2 Technological Shocks

Table 4 documents the effects on key macroeconomic variables resulting from increases in productivity of traded and non traded sectors. In the perfectly competitive model and irrespective of the sectoral capital intensities, a productivity growth in the traded sector, A^T, is exactly matched by a proportional one-for-one relative price appreciation. Unlike, the monopolistic model illustrates the influence of markup as an additional channel transmitting supply shock to the relative price since the appreciation is amplified: 4.2% when $k^T > k^N$ and 4.6% when $k^N > k^T$ following a 4% increase in A^T. The productivity growth in the traded sector affects the consumption of non traded goods trough two offsetting effects: the negative price effect and the positive wealth effect. Numerical experiments show that the price effect may offset the wealth one, causing non traded consumption to fall in equilibrium. As a consequence, the price elasticity declines and monopolistic firms are willing to fix higher markup which in turn reinforces the initial relative price appreciation.

Unlike the case of a shift in A^T, a technological improvement occurring in the non traded sector translates into higher capital intensities. Under perfect competition, the relative price depreciates and its fall is related to the capital intensities: -1.7% and -2.3% depending on wether $k^T \gtrless k^N$. Regarding the model with monopolistic competition, because the consumption of non traded goods raises through the price and wealth effects, the markup falls unambiguously since a greater part of non traded goods demand reacts to relative price changes. In order to maintain the no-arbitrage condition (26a), the relative price falls by a greater amount to compensate both the increase in A^N and the reduction in $\tilde{\mu}$: -2.1% (-3.1%) when $k^T > k^N$ $(k^N > k^T)$.

Regardless the sectoral capital intensities, the economy responds to an increase in A^T by moving labor from the non traded to the traded sector, by reducing its capital stock and by accumulating foreign bonds. The Table 5 displays the sensitivity of current account and investment responses for variations in ρ and ϕ. These parameters, which parameterize the price elasticity for non traded goods, may govern the extent to which the shift in productivity alters the model. Reduce the intratemporal elasticity of substitution, ϕ, may change the direction of current account and investment responses compared to the benchmark scenario. When $k^N > k^T$, taking a lower value for ϕ instead of 1.50 results in capital accumulation and net foreign assets position deterioration (rather than $\mathrm{d}\tilde{K} < 0$ and $\mathrm{d}\tilde{b} > 0$ in the benchmark). When $k^T > k^N$, signs of steady-state changes in $\tilde{K}$ and $\tilde{b}$ in the monopolistic model may be reversed compared to the corresponding perfectly framework for low values of ϕ.

Unlike technological shocks on A^T, the responses of capital stock and foreign assets position following a rise in A^N are insensitive to sectoral capital intensities and to the intensity of competition in the non traded goods market. Indeed, a positive shock to A^N always worsens the current account and boosts investment. While capital stock increases exhibit similar magnitudes in both models, the responses of the external position are more pronounced and more variable. For example, the monopolistic model entails deterioration of the stock of foreign bonds about 11% and 4.1% when $k^T > k^N$ and $k^N > k^T$ respectively. These are quite significant values considering the limited productivity growth observed in the non traded sector (2%). By contrast, technological shocks originating from the traded sector trigger soften reactions of the foreign assets position, suggesting that non traded productivity gains are the prime determinant of the current account in our model. This finding is consistent with İşcan's [2000] empirical results (Table 5, p. 604), which are drawn from a two-sector intertemporal open economy model. More recently, Cova et al. [2008] find that TFP developments in the non traded goods sector can broadly account for the current account patterns in the U.S., Japan, and in the euro area since 1999.

3.3 The Balassa-Samuelson Effect

The two-sector model of Turnovsky and Sen [1995] offers a suitable and tractable framework for investigating the relative price responses to sectoral productivity growth differential, i.e. the Balassa-Samuelson effect (Balassa [1964] and Samuelson [1964]). The core of their analyze is identifying productivity growth differential between the traded and non traded sectors as a key variable to determine the evolution of the long-run relative price. Assuming perfect competition, the relative price variation induced by a productivity growth differential is computed as:

$$\hat{p} = \hat{A}^T - \left(\frac{1-\theta^T}{1-\theta^N}\right)\hat{A}^N, \tag{27}$$

where a hat above a variable denotes the steady-state deviation after the shock occurred ($\hat{x} = (\tilde{x}-\tilde{x}_0)/\tilde{x}_0$). From (27), it follows that the strength and the direction of the Balassa-Samuelson effect in the competitive model depends only on factor intensities (θ^T and θ^N). These two parameters in turn determine the extent to which the differential in sectoral productivity growth ($\hat{A}^T - \hat{A}^N$) alters the relative price. Relaxing the perfect competition assumption makes the Balassa-Samuelson effect dependent of markup growth rate which amplifies or dampens the effect of technological disturbances on relative price according to

$$\hat{p} = \hat{\mu} + \hat{A}^T - \left(\frac{1-\theta^T}{1-\theta^N}\right)\hat{A}^N. \tag{28}$$

Due to price-setting behavior of non traded firms, equation (28) shows that the response of the relative price in the monopolistic model does not correspond to the standard Balassa-Samuelson effect. The existence of market power implies that the endogenous response of markup in the non traded sector introduces an additional channel to understand the evolution of the relative price after productivity shocks. Thus, if one assumes that non traded firms are perfectly competitive when they are not, one can be led to misestimate the Balassa-Samuelson effect. Table 2 depicts the sensitivity of the relative price response to a technological changes biased toward the traded sector ($\hat{A}^T - \hat{A}^N = 2\%$) to variations in parameters ρ and ϕ.

In the perfectly model, the relative price is entirely supply-side determined and appreciates by 2.3% when $k^T > k^N$ and 1.6% when $k^N > k^T$. In contrast, the presence of monopolistic

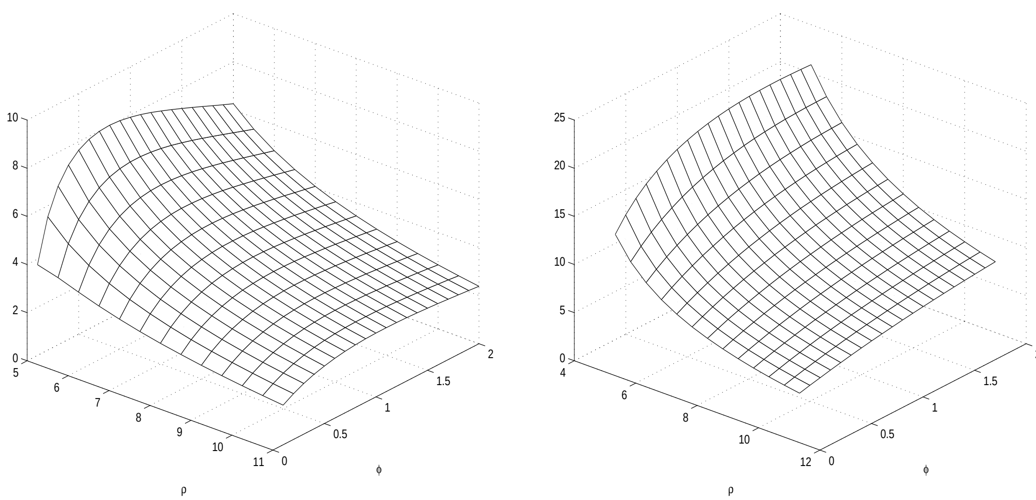
Table 2: Sensitivity Analysis to the Balassa-Samuelson Effect

	Monopolistic Competition ($\rho =$)											PC
	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	
$\phi =$	$k^T > k^N$											
2.00	2.19	2.19	2.20	2.20	2.21	2.21	2.22	2.22	2.22	2.23	2.23	2.27
1.50	2.10	2.13	2.15	2.16	2.17	2.18	2.19	2.19	2.20	2.20	2.21	2.27
1.00	2.11	2.13	2.14	2.16	2.17	2.18	2.18	2.19	2.20	2.20	2.20	2.27
0.70	2.11	2.13	2.15	2.16	2.17	2.18	2.19	2.19	2.20	2.20	2.21	2.27
0.30	2.13	2.15	2.16	2.17	2.18	2.18	2.19	2.20	2.20	2.21	2.21	2.27
	$k^N > k^T$											
2.00	1.40	1.43	1.45	1.46	1.48	1.49	1.49	1.50	1.51	1.51	1.52	1.59
1.50	1.34	1.38	1.41	1.43	1.44	1.46	1.47	1.48	1.49	1.49	1.50	1.59
1.00	1.32	1.36	1.38	1.41	1.42	1.44	1.45	1.46	1.47	1.48	1.48	1.59
0.70	1.32	1.35	1.38	1.40	1.42	1.43	1.44	1.45	1.46	1.47	1.48	1.59
0.30	1.31	1.35	1.37	1.39	1.41	1.42	1.44	1.45	1.46	1.46	1.47	1.59

Notes: PC = Perfect Competition.

competition and markup tends to modify the Balassa-Samuelson effect. The evidence in Table 2 shows that the competitive Balassa-Samuelson effect exceeds the one prevailing in the monopolistic framework. This suggests that the endogenous response of the markup softens the relative price appreciation, i.e. the bias due to the omission of the imperfect competition is positive and leads to overestimate the Balassa-Samuelson hypothesis in a competitive framework. This bias may be computed as $(\hat{p}_{pc} - \hat{p})/\hat{p}$, where $\hat{p}_{pc}$ corresponds to the steady-state deviation derived inside the competitive framework, and is plotted against different values of ρ and ϕ in Figure 1.

Figure 1: The Balassa-Samuelson Effect Bias (in %)



$k^T > k^N$ $\qquad\qquad$ $k^N > k^T$

When $k^T > k^N$, the bias reaches its peak at 8% for $\rho = 5$ and $\phi = 1.30$ and vanishes as the elasticity between non traded varieties tends to infinity. The bias is relatively insensitive to the intratemporal substitution elasticity but much more to ρ. The monopolistic model when $k^N > k^T$ gives rise to larger bias. For $\rho = 5$ it attains 14%, 21% and 21% for $\phi = 2.00$, $\phi = 1.00$ and $\phi = 0.30$ respectively. Interestingly, even high values of the elasticity between non traded varieties produce significant bias (around 6% for $\rho = 10$ and $\phi = 1.50$).

Our results indicate that, in estimating the Balassa-Samuelson effect, it is important to relax the restrictive assumption of perfect competition. Not permitting for a monopolistic competition in the non traded sector biases upward estimates of the Balassa-Samuelson hypothesis.

4 Conclusion

The purpose of this paper, drawing on earlier work by Turnovsky and Sen [1995], has been to examine the implications of introducing imperfect competition in an intertemporal two-sector small open economy model. The market structure in the non traded sector considered includes a Dixit and Stiglitz [1977] monopolistic competition and endogenous markups which depend on the composition of aggregate demand for non traded goods.

The quantitative simulations show that the monopolistic competition hypothesis is helpful in reproducing key stylized facts in the international macroeconomic literature. The model replicates reasonably the pattern of savings-investment correlations in OECD countries, without relaxing the perfect capital mobility hypothesis. Accordingly, the model has strong implications for the Feldstein-Horioka [1980] puzzle since it suggests a new explanation stemming from the monopolistic competition assumption in the non traded goods sector and from the existence of positive profits distributed to households. Moreover, introducing monopolistic competition into the model adds new potential sources of relative price movements. Following a positive fiscal shocks, the model features relative price appreciations, as the empirical literature found. In addition, numerical analysis shows that the relative price responses to technological shocks differ from the ones prevailing in the perfectly competitive model. This outcome has important implications since assume perfect competition when it is not, biases upward estimates of the Balassa-Samuelson hypothesis. Consequently, the paper poses the need for new empirical studies that take account of the degree of competition in the economy when assessing the link between productivity differentials and the relative price of non traded goods. Finally, the responses of the current account and investment to fiscal and technological shocks may be reversed in the monopolistically competitive model compared to those derived in the perfectly competitive framework. For the effects following fiscal policies, it has be shown that the relative price variations provide an additional channel through which demand shocks alter the current account and investment. Furthermore, productivity disturbances are quite dependent on the origin of the shock and from the markets degree of competition.

Appendix

A Short-run static solutions

By differentiating (4a) and substituting into (5), the derivatives of c^T and c^N write as follows:

$$c^T_{\bar{\lambda}} = -\sigma \frac{c^T}{\bar{\lambda}} < 0, \qquad c^T_p = \alpha \frac{c^T}{p} (\phi - \sigma) \lesseqgtr 0, \tag{A1a}$$

$$c^N_{\bar{\lambda}} = -\sigma \frac{c^N}{\bar{\lambda}} < 0, \qquad c^N_p = -\frac{c^N}{p} \left[(1-\alpha)\phi + \alpha\sigma\right] < 0, \tag{A1b}$$

where σ is the intertemporal elasticity of substitution and ϕ is the intratemporal elasticity of substitution. By substituting (A1b) into the definition of $\mu(z)$ yields the partial derivatives:

$$\mu_{\bar{\lambda}} = \sigma \frac{\mu(z)^2 g^N(z)}{\bar{\lambda}\rho c^N(z)} > 0, \quad \mu_{p(z)} = \frac{\mu(z)^2 g^N(z)}{p(z) c^N(z)} > 0, \quad \mu_{g^N(z)} = \frac{\mu(z)^2}{\rho c^N(z)} > 0. \tag{A2}$$

Totally differentiating conditions (18a) and (18b) with respect to p leads to:

$$k^T_p = \frac{A^N h}{\mu A^T f_{kk} \left(k^N - k^T\right)} \lesseqgtr 0, \qquad k^N_p = \frac{\mu A^T f}{p^2 A^N h_{kk} \left(k^N - k^T\right)} \lesseqgtr 0. \tag{A3}$$

Substituting (A3) into (11) and totally differentiating, one can obtain:

$$L^T_K = \frac{1}{k^T - k^N} \lesseqgtr 0, \quad L^T_p = \frac{1}{\left(k^T - k^N\right)^2} \left[\frac{L^T A^N h}{\mu A^T f_{kk}} + \frac{L^N \mu A^T f}{p^2 A^N h_{kk}}\right] < 0, \tag{A4a}$$

$$L^N_K = \frac{1}{k^N - k^T} \lesseqgtr 0, \quad L^N_p = -\frac{1}{\left(k^T - k^N\right)^2} \left[\frac{L^T A^N h}{\mu A^T f_{kk}} + \frac{L^N \mu A^T f}{p^2 A^N h_{kk}}\right] > 0. \tag{A4b}$$

Similarly, the traded and non traded outputs can be solved in the form:

$$Y^T_K = \frac{A^T f}{k^T - k^N} \lesseqgtr 0, \quad Y^T_p = \frac{1}{\left(k^T - k^N\right)^2} \left[\frac{L^T p \left(A^N h\right)^2}{\mu^2 A^T f_{kk}} + \frac{L^N \mu \left(A^T f\right)^2}{p^2 A^N h_{kk}}\right] < 0, \tag{A5a}$$

$$Y^N_K = \frac{A^N h}{k^N - k^T} \lesseqgtr 0, \quad Y^N_p = -\frac{1}{p\left(k^T - k^N\right)^2} \left[\frac{L^N \left(\mu A^T f\right)^2}{p^2 A^N h_{kk}} + \frac{L^T p \left(A^N h\right)^2}{\mu A^T f_{kk}}\right] > 0. \tag{A5b}$$

B Dynamics and Stables Solutions

When $k^T > k^N$, the eigenvalues are given by:

$$\nu_1 = -\frac{A^N h}{k^T - k^N} < 0, \qquad \nu_2 = \frac{A^T f}{p\left(k^T - k^N\right)} > 0, \tag{B1}$$

with $\omega_1 = 0$. In this case, the formal expressions for Ω, Φ and Υ are given by :

$$\Omega = -\tilde{p} \left[1 - \left(\frac{\tilde{\mu} - 1}{\tilde{\mu}}\right) \left(\frac{r^* - \nu_2}{\left(\frac{\tilde{\mu}-1}{\tilde{\mu}}\right) r^* - \nu_2}\right)\right] < 0, \tag{B2a}$$

$$\Phi = \Upsilon = \tilde{p} \left(\frac{\tilde{\mu} - 1}{\tilde{\mu}}\right) \left(\frac{r^* - \nu_2}{\left(\frac{\tilde{\mu}-1}{\tilde{\mu}}\right) r^* - \nu_2}\right) > 0. \tag{B2b}$$

In the alternative situation, $k^N > k^T$, the eigenvalues are the following:

$$\nu_1 = \frac{A^T f}{p\left(k^T - k^N\right)} < 0, \qquad \nu_2 = \frac{A^N h}{k^N - k^T} > 0, \tag{B3}$$

and $\omega_1 = -\frac{\nu_2 - \nu_1}{\left(Y_p^N - c_p^N\right)} < 0$. The terms Ω, Φ and Υ can be written as:

$$\Omega = -\tilde{p}\left[1 + (\tilde{\mu} - 1) + \frac{\tilde{\mu}\omega_1}{\tilde{p}\nu_2}\left(Y_p + \sigma\tilde{c}^N\right)\right] \gtrless 0, \tag{B4a}$$

$$\Phi = -\tilde{p}\left[(\tilde{\mu} - 1) + \frac{\tilde{\mu}\omega_1}{\tilde{p}\nu_2}\left(Y_p - \frac{\tilde{K}\nu_2}{\tilde{\mu}} + \sigma\tilde{c}^N\right)\right] \gtrless 0, \tag{B4b}$$

$$\Upsilon = -\tilde{p}\left[(\tilde{\mu} - 1) + \frac{\tilde{\mu}\omega_1}{\tilde{p}\nu_2}\left(Y_p - \frac{\tilde{Y}^N}{\tilde{\mu}}\right)\right] \gtrless 0, \tag{B4c}$$

where Y_p is the partial derivative of the national output with respect to the relative price p with $Y_p = p\left(1 - \frac{1}{\mu}\right) Y_p^N > 0$.

C Numerical Simulations

Table 3: Steady-State Ratios

	$k^T > k^N$		$k^N > k^T$		Data	
	MC	PC	MC	PC	Range	Average
(a) g^T/Y^T	0.06	0.06	0.07	0.07	0.01 - 0.15	0.04
(b) g^N/Y^N	0.31	0.30	0.32	0.33	0.13 - 0.75	0.41
(c) g^N/g	0.82	0.90	0.90	0.90	0.83 - 0.99	0.93
(d) g/Y	0.19	0.22	0.23	0.24	0.09 - 0.51	0.26
(e) Y^N/Y	0.59	0.66	0.66	0.67	0.41 - 0.73	0.59
(f) c^N/c	0.38	0.41	0.43	0.49	0.33 - 0.51	0.43
(g) μ	1.44		1.49		1.26 - 1.87	1.45
(h) corr(S, I)	0.75	0.00	0.20	-0.19	0.10 - 0.97	0.61

Notes: MC = Monopolistic Competition, PC = Perfect Competition.

Ranges and averages for rows (a)-(e) are drawn from Morshed and Turnovsky [2004]. Empirical estimates for c^N/c are taken from Stockman and Tesar [1995]. Markup estimates on row (g) are provided by Christopoulou and Vermeulen [2008]. Finally, savings-investment correlations estimates, corr(S, I), come from Ubide [1999].

Table 4: Steady-State Deviations to Fiscal and Technological Shocks

$k^T > k^N$															
		$\mathrm{d}\tilde{k}^T$	$\mathrm{d}\tilde{k}^N$	$\mathrm{d}\tilde{p}$	$\mathrm{d}\tilde{\mu}$	$\mathrm{d}\tilde{L}^T$	$\mathrm{d}\tilde{K}$	$\mathrm{d}\tilde{b}$	$\mathrm{d}\bar{\lambda}$	$\mathrm{d}\tilde{c}$	$\mathrm{d}\tilde{c}^T$	$\mathrm{d}\tilde{c}^N$	$\mathrm{d}\tilde{\pi}^c$	$\mathrm{d}\tilde{Y}^T$	$\mathrm{d}\tilde{Y}^N$
$\mathrm{d}g^T$	PC	0.00	0.00	0.00		4.49	0.61	-0.68	4.08	-2.76	-2.76	-2.76	0.00	4.49	-1.94
	MC	-0.91	-0.91	0.50	0.60	2.04	-0.46	1.27	5.33	-3.69	-3.42	-4.15	0.19	1.62	-2.87
$\mathrm{d}g^N$	PC	0.00	0.00	0.00		-6.02	-0.81	0.91	3.86	-2.61	-2.61	-2.61	0.00	-6.02	2.60
	MC	-4.60	-4.60	2.62	3.11	-2.22	-5.08	14.08	3.42	-2.99	-1.56	-5.32	0.98	-4.27	1.11
$\mathrm{d}A^T$	PC	0.00	0.00	4.00		3.63	0.49	-0.57	-3.28	1.21	3.69	-2.23	1.63	7.77	-1.57
	MC	-0.41	-0.41	4.24	0.27	0.94	-0.20	0.58	-4.26	1.98	4.38	-1.91	1.56	4.78	-1.32
$\mathrm{d}A^N$	PC	3.09	3.09	-1.66		2.73	3.47	-3.83	-0.98	1.18	0.13	2.68	-0.69	4.14	1.88
	MC	3.84	3.84	-2.05	-0.47	0.68	4.00	-10.93	-1.45	1.58	0.40	3.57	-0.78	2.41	2.47

$k^N > k^T$															
		$\mathrm{d}\tilde{k}^T$	$\mathrm{d}\tilde{k}^N$	$\mathrm{d}\tilde{p}$	$\mathrm{d}\tilde{\mu}$	$\mathrm{d}\tilde{L}^T$	$\mathrm{d}\tilde{K}$	$\mathrm{d}\tilde{b}$	$\mathrm{d}\bar{\lambda}$	$\mathrm{d}\tilde{c}$	$\mathrm{d}\tilde{c}^T$	$\mathrm{d}\tilde{c}^N$	$\mathrm{d}\tilde{\pi}^c$	$\mathrm{d}\tilde{Y}^T$	$\mathrm{d}\tilde{Y}^N$
$\mathrm{d}g^T$	PC	0.00	0.00	0.00		3.81	-0.54	1.33	4.80	-3.23	-3.23	-3.23	0.00	3.81	-2.18
	MC	-1.22	-1.22	0.80	0.68	2.42	-1.69	1.49	4.77	-3.44	-2.94	-4.10	0.35	1.98	-2.77
$\mathrm{d}g^N$	PC	0.00	0.00	0.00		-4.17	0.59	-1.46	5.09	-3.42	-3.42	-3.42	0.00	-4.17	2.38
	MC	-4.96	-4.96	3.37	2.84	-2.38	-4.52	4.01	2.60	-2.76	-0.65	-5.46	1.44	-4.11	-0.12
$\mathrm{d}A^T$	PC	0.00	0.00	4.00		1.87	-0.26	0.68	-3.85	1.41	4.38	-1.58	1.94	5.95	-1.07
	MC	-0.88	-0.88	4.60	0.49	1.77	-1.23	1.12	-3.03	0.80	3.78	-2.99	1.96	5.51	-2.03
$\mathrm{d}A^N$	PC	3.67	3.67	-2.31		2.41	3.31	-7.98	-0.98	1.51	-0.24	3.33	-1.15	3.71	2.24
	MC	5.02	5.02	-3.13	-0.71	1.10	4.79	-4.09	-1.38	1.97	-0.13	4.75	-1.38	2.84	3.21

Table 5: Sensitivity Analysis to Fiscal and Technological Shocks

		Monopolistic Competition ($\rho =$)							PC	Monopolistic Competition ($\rho =$)							PC
		5	6	7	8	9	10	11		5	6	7	8	9	10	11	
	$\phi =$				$\mathrm{d}g^T$				$k^T > k^N$				$\mathrm{d}g^N$				
$\mathrm{d}\tilde{K}$	2.00	-1.53	-0.62	-0.31	-0.15	-0.05	0.02	0.06	0.47	-10.63	-5.36	-3.79	-3.00	-2.52	-2.19	-1.96	-0.89
	0.70	0.33	0.42	0.47	0.51	0.53	0.55	0.56	0.88	-2.53	-2.01	-1.69	-1.48	-1.32	-1.20	-1.11	-0.67
	0.30	0.56	0.62	0.65	0.67	0.69	0.70	0.71	1.02	-2.14	-1.73	-1.47	-1.29	-1.16	-1.06	-0.98	-0.59
$\mathrm{d}\tilde{b}$	2.00	3.04	1.23	0.62	0.30	0.10	-0.03	-0.13	-0.57	21.14	10.72	7.59	6.01	5.05	4.40	3.93	1.09
	0.70	-0.66	-0.84	-0.94	-1.01	-1.07	-1.10	-1.13	-0.84	5.06	4.03	3.39	2.96	2.65	2.41	2.23	0.64
	0.30	-1.12	-1.23	-1.30	-1.35	-1.38	-1.40	-1.42	-0.91	4.27	3.46	2.94	2.58	2.32	2.12	1.96	0.53
									$k^N > k^T$								
$\mathrm{d}\tilde{K}$	2.00	-1.81	-1.22	-1.00	-0.89	-0.82	-0.77	-0.73	-0.53	-5.37	-2.75	-1.81	-1.32	-1.01	-0.80	-0.65	0.60
	0.70	-1.16	-1.00	-0.90	-0.84	-0.79	-0.76	-0.73	-0.55	-1.96	-1.38	-1.04	-0.82	-0.66	-0.54	-0.45	0.58
	0.30	-1.11	-0.98	-0.89	-0.84	-0.80	-0.76	-0.74	-0.56	-1.64	-1.19	-0.91	-0.72	-0.59	-0.48	-0.40	0.57
$\mathrm{d}\tilde{b}$	2.00	1.68	1.63	1.71	1.84	1.98	2.13	2.28	1.31	5.04	3.67	3.10	2.73	2.46	2.24	2.04	-1.47
	0.70	1.50	1.70	1.90	2.09	2.29	2.48	2.67	1.38	2.55	2.36	2.19	2.04	1.90	1.76	1.63	-1.44
	0.30	1.55	1.77	1.99	2.20	2.41	2.62	2.82	1.41	2.29	2.16	2.03	1.91	1.78	1.66	1.54	-1.43
					$\mathrm{d}A^T$				$k^T > k^N$				$\mathrm{d}A^N$				
$\mathrm{d}\tilde{K}$	2.00	-1.46	-0.55	-0.26	-0.12	-0.04	0.01	0.05	0.61	4.96	4.11	3.82	3.67	3.58	3.52	3.47	3.34
	0.70	-0.04	-0.06	-0.08	-0.09	-0.10	-0.11	-0.12	0.21	3.72	3.66	3.62	3.60	3.58	3.57	3.56	3.70
	0.30	-0.14	-0.17	-0.20	-0.21	-0.23	-0.24	-0.25	0.08	3.77	3.72	3.69	3.67	3.66	3.64	3.64	3.90
$\mathrm{d}\tilde{b}$	2.00	2.91	1.09	0.52	0.24	0.08	-0.03	-0.10	-0.78	-9.88	-8.22	-7.65	-7.36	-7.18	-7.06	-6.97	-4.03
	0.70	0.07	0.12	0.15	0.18	0.20	0.22	0.24	-0.21	-7.44	-7.33	-7.26	-7.22	-7.18	-7.16	-7.14	-3.54
	0.30	0.28	0.34	0.39	0.43	0.46	0.48	0.50	-0.07	-7.54	-7.45	-7.40	-7.36	-7.34	-7.32	-7.30	-3.41
									$k^N > k^T$								
$\mathrm{d}\tilde{K}$	2.00	-2.14	-1.29	-0.98	-0.82	-0.72	-0.66	-0.61	-0.43	5.43	4.59	4.27	4.09	3.98	3.91	3.85	3.42
	0.70	-0.05	0.00	0.03	0.04	0.06	0.06	0.07	-0.01	3.67	3.56	3.49	3.45	3.42	3.39	3.38	3.15
	0.30	0.22	0.23	0.24	0.24	0.25	0.25	0.25	-0.13	3.43	3.37	3.32	3.30	3.28	3.26	3.25	3.06
$\mathrm{d}\tilde{b}$	1.50	2.07	1.79	1.74	1.77	1.82	1.89	1.97	1.10	-4.90	-5.94	-7.09	-8.25	-9.41	-10.56	-11.69	-8.16
	0.70	0.07	0.00	-0.06	-0.11	-0.16	-0.21	-0.26	0.01	-4.63	-5.90	-7.15	-8.38	-9.60	-10.81	-12.00	-7.69
	0.30	-0.32	-0.44	-0.56	-0.67	-0.77	-0.87	-0.97	-0.34	-4.67	-5.94	-7.21	-8.46	-9.69	-10.91	-12.12	-7.54

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