Macroeconomic Dynamics, **19**, 2015, 1839–1865. Printed in the United States of America.
doi:10.1017/S1365100514000133

FISCAL SHOCKS IN A TWO-SECTOR OPEN ECONOMY WITH ENDOGENOUS MARKUPS

OLIVIER CARDI
University Panthéon-Assas CRED

ROMAIN RESTOUT
Université de Lorraine BETA
and
UCL IRES

We use a two-sector neoclassical open economy model with traded and nontraded goods and endogenous markups to investigate the effects of temporary fiscal shocks. One central finding is that theory can be reconciled with evidence once we allow for endogenous markups and assume that the traded sector is more capital-intensive than the nontraded sector. More precisely, although both ingredients are essential to produce the real exchange rate depreciation, only the second ingredient is necessary to account for the simultaneous decline in investment and the current account, in line with the evidence.

Keywords: Nontraded Goods, Fiscal Shocks, Investment, Current Account, Endogenous Markup

1. INTRODUCTION

There has recently been a revival of interest among policy makers in the fiscal policy tool. The fiscal transmission mechanism has also attracted considerable attention in the academic literature. A number of papers have explored the ability of quantitative business cycle models of both the neoclassical and the new Keynesian variety to account for the data; see, e.g., Burnside et al. (2004), and Gali et al. (2007).[1] However, most analyses have been confined to closed economy

Constructive comments by Sophie Béreau, Clément Carbonnier, Etienne Lehmann, Jean-Christophe Poutineau, and Stefan Schubert are gratefully acknowledged. An earlier version of this paper was presented to the 12th Spring Meeting of Young Economists held in Hamburg, 25–27 May 2007, the 12th Conference Theories and Methods of Macroeconomics held in Paris, 17–18 January 2008, the 14th International Conference on Computing in Economics and Finance held in Paris, 26–28 June 2008, the 60th Congress of the French Association of Economics held in Paris, 8–9 September 2011, the University of Bolzano lunch seminar, 11 June 2013, and the Conference on Economic and Financial Adjustments in Europe, Lisbon, 28 June 2013, and has benefited from the very helpful comments of participants. Finally, we would like to thank the associate editor and one anonymous referee for very constructive suggestions and remarks thath improved both the content and the exposition of a previous draft. Of course the usual disclaimers apply. Romain Restout wishes to express his gratitude to the Belgian Federal Government for its financial support (Grant PAI P6/07 on "Economic Policy and Finance in the Global Economy: Equilibrium Analysis and Social Evaluation"). Address correspondence to: Olivier Cardi, Université Panthéon-Assas Paris 2, CRED, 12 Place du Panthéon, 75230 Paris Cedex 05. France; e-mail: olivier.cardi@u-paris2.fr.

 1365-1005/14

models and to one-sector frameworks.[2] In the present paper we instead address the following question: to what extent can an open economy version of the two-sector neoclassical model account for the evidence on the fiscal policy transmission mechanism?

Several empirical studies have explored open economy aspects of the fiscal transmission mechanism. One of the most prominent and consistent set of empirical findings that emerges is that a rise in public spending produces a contained increase in GDP and a simultaneous decline in investment and the current account, and most importantly, depreciates the real exchange rate; see, e.g., Monacelli and Perotti (2010), Enders et al. (2011), and Corsetti et al. (2012).[3] Monacelli and Perotti (2010) show that a New Keynesian model can account for these findings, notably the fall in domestic prices relative to foreign prices, as long as preferences are nonseparable between consumption and leisure.[4] One major contribution of our paper is to show that the neoclassical model can account for the real exchange rate depreciation along with the simultaneous decline in investment and the current account, once we allow for endogenous markups and the traded sector is assumed to be more capital-intensive.[5] Our analysis complements Monacelli and Perotti's (2010) study by showing that the combined effect of countercyclical markups and input reallocation across sectors generates a real exchange rate depreciation after a temporary fiscal expansion in a model with flexible prices, albeit under certain conditions.

Intuitively, whether the traded sector is more or less capital-intensive than the nontraded sector, resources are shifted toward the nontraded sector because public purchases disproportionately benefit this sector.[6] As the rise in government spending boosts nontraded output, profit opportunities trigger the entry of new firms.[7] Hence, the markup falls, regardless of sectoral capital intensities. Because producers with market power mark up prices over the unit cost, the real exchange rate depreciates if both the markup and the unit cost fall or the decline in the markup more than offsets the rise in the unit cost. The change in the unit cost crucially depends on sectoral capital–labor ratio adjustments.[8] When the traded sector is more capital-intensive, for a given real exchange rate, the reallocation of inputs keeps sectoral capital–labor ratios fixed so that the unit cost is unaffected. More precisely, a temporary increase in government spending, by implying a rise in future taxes (which we assume to be lump-sum), induces Ricardian agents to increase labor supply, which drives down sectoral capital–labor ratios. At the same time, because resources are shifted toward the nontraded sector whereas the traded sector is more capital-intensive, capital increases in relative abundance.[9] Hence, the sectoral capital–labor ratios return to their initial values, thus leaving the unit cost for producing unaffected. Because the markup falls, nontraded producers set lower prices so that the real exchange rate depreciates, in line with the evidence. Conversely, when the traded sector is more labor-intensive, labor rises in relative abundance. Consequently, capital–labor ratios fall dramatically. The return on domestic capital rise, which pushes up the unit cost by such an amount that the real exchange rate appreciates (while the markup falls).

By affecting the return on domestic capital, the reallocation of inputs across sectors also plays a key role in the determination of the responses of investment and the current account. To see this, consider a temporary increase in government spending. As stressed in the classic paper by Baxter and King (1993), households respond to a temporary fiscal expansion by lowering savings, as they try to avoid a large reduction in consumption and/or a large increase in labor supply. Reduced savings imply a decline in investment or the current account, or both. As mentioned previously, because the reallocation of inputs across sectors keeps sectoral capital–labor ratios fixed when the traded sector is more capital-intensive, the return on domestic capital is unaffected in this case. Hence, the fall in savings drives down both investment and the current account, in line with the evidence. With the reversal of sectoral capital intensities, the two-sector model fails to produce a decline in investment. When the nontraded sector is more capital-intensive, the large increase in the return of domestic capital induces agents to accumulate physical capital, so that investment is crowded in instead of being crowded out.

To address the real exchange depreciation after a temporary fiscal expansion, we draw on earlier work by Turnovsky and Sen (1995), who develop an open economy model with a traded and a nontraded sector, but assume elastic labor supply and imperfect competition in product markets. Coto-Martinez and Dixon (2003) employ a similar framework to investigate the output effects of fiscal shocks, but they restrict their analysis to a permanent rise in public spending and assume fixed markups. When the markups are fixed, the real exchange rate is unaffected if the traded sector is more capital-intensive or appreciates with the reversal of sectoral capital intensities, in contradiction to the evidence. Moreover, in contrast to the authors, we analyze the implications of a temporary fiscal expansion. Beyond the fact that considering a transitory increase in public spending allows us to address the VAR evidence, a temporary fiscal shock may lower investment, whereas a permanent fiscal shock always stimulates it.[10]

The remainder of this paper is organized as follows. Section 2 outlines the specification of a two-sector model with traded and nontraded goods. The nontraded sector is assumed to be imperfectly competitive with an endogenous markup. In Section 3, we provide an analytical exploration of the effects of temporary fiscal shocks, shedding light on the fiscal transmission with an endogenous markup. In Section 4, we report the results of our numerical simulations and assess the ability of the model to account for the evidence. In Section 5, we summarize our main results and present our conclusions.

2. THE FRAMEWORK

We consider a small open economy that is populated by a constant number of identical households and firms that have perfect foresight and live forever.[11] The country is small in terms of both world goods and capital markets, and faces a given world interest rate, $r^{\star}$. A perfectly competitive sector produces a traded good denoted by the superscript T that can be exported and consumed

https://doi.org/10.1017/S1365100514000133 Published online by Cambridge University Press

domestically. An imperfectly competitive sector produces a nontraded good denoted by the superscript N that is devoted to physical capital accumulation and domestic consumption.[12] The traded good is chosen as the numeraire.[13]

2.1. Households

At each instant the representative agent consumes traded goods and nontraded goods, denoted by C^T and C^N, respectively, which are aggregated by a constant-elasticity-of-substitution function,

$$C(C^T, C^N) = \left[\varphi^{\frac{1}{\phi}}(C^T)^{\frac{\phi-1}{\phi}} + (1-\varphi)^{\frac{1}{\phi}}(C^N)^{\frac{\phi-1}{\phi}}\right]^{\frac{\phi}{\phi-1}}, \qquad (1)$$

where φ is the weight attached to the traded good in the overall consumption bundle ($0 < \varphi < 1$) and ϕ is the intratemporal elasticity of substitution ($\phi > 0$).

The agent is endowed with a unit of time and supplies a fraction $L(t)$ of this unit as labor; the remainder, $l \equiv 1 - L$, is consumed as leisure. At any instant of time, households derive utility from their consumption and experience disutility from working. Households decide on consumption and worked hours by maximizing lifetime utility:

$$U = \int_0^\infty \left\{\frac{1}{1-\frac{1}{\sigma_C}} C(t)^{1-\frac{1}{\sigma_C}} - \gamma \frac{1}{1+\frac{1}{\sigma_L}} L(t)^{1+\frac{1}{\sigma_L}}\right\} e^{-\beta t} dt, \qquad (2)$$

where β is the consumer's discount rate, $\sigma_C > 0$ is the intertemporal elasticity of substitution for consumption, and $\sigma_L > 0$ is the Frisch elasticity of labor supply.

Factor income is derived by supplying labor L at a wage rate W and capital K at a rental rate R. In addition, they accumulate internationally traded bonds, $B(t)$, that yield net interest rate earnings of $r^\star B(t)$. Denoting lump-sum taxes by Z, the households' flow budget constraint can be written as

$$\dot{B}(t) = r^\star B(t) + R(t)K(t) + W(t)L(t) - Z - P_C(P(t))\, C(t) - P(t)I(t), \quad (3)$$

where P_C is the consumption price index, which is a function of the relative price of nontraded goods, P. The last two terms represent households' expenditure, which includes purchases of consumption goods and investment expenditure PI. Aggregate investment gives rise to overall capital accumulation according to the dynamic equation

$$\dot{K}(t) = I(t) - \delta_K K(t), \qquad (4)$$

where we assume that physical capital depreciates at rate δ_K. In the rest of this paper, the time argument is suppressed in order to increase clarity.

Denoting the co-state variable associated with equation (3) by λ, the first-order conditions characterizing the representative household's optimal plans are

$$C = (P_C \lambda)^{-\sigma_C}, \tag{5a}$$

$$L = [(\lambda/\gamma)\, W]^{\sigma_L}, \tag{5b}$$

$$\dot{\lambda} = \lambda(\beta - r^\star), \tag{5c}$$

$$R/P - \delta_K + \dot{P}/P = r^\star, \tag{5d}$$

plus the appropriate transversality conditions. In an open economy model with a representative agent having perfect foresight, a constant rate of time preference, and perfect access to world capital markets, we impose $\beta = r^\star$ in order to generate an interior solution. This standard assumption made in the literature implies that the marginal utility of wealth, λ, will undergo a discrete jump when individuals receive new information and must remain constant over time thereafter, i.e., $\lambda = \bar{\lambda}$.

The homogeneity of $C(.)$ allows a two-stage consumption decision: in the first stage, consumption is determined, and the intratemporal allocation between traded and nontraded goods is decided at the second stage. Applying Shephard's lemma gives $C^N = P_C' C$, where $P_C' = \partial P_C / \partial P$; denoting by α_C the share of nontraded goods in the consumption expenditure, we have $C^N = \alpha_C P_C C/P$ and $C^T = P_C C - P C^N = (1 - \alpha_C)\, P_C C$.[14]

2.2. Firms

Both the traded and nontraded sectors use physical capital, K^T and K^N, and labor, L^T and L^N, according to Cobb–Douglas production functions $Y^T = (K^T)^{\theta^T} (L^T)^{1-\theta^T}$ and $Y^N = (K^N)^{\theta^N} (L^N)^{1-\theta^N}$, where θ^T and θ^N represent the capital income share in output in the traded and nontraded sectors respectively. Both sectors face two cost components: a capital rental cost equal to R and a labor cost equal to the wage rate W. The traded sector is assumed to be perfectly competitive. As described in more detail later, the nontraded sector contains a large number of industries and each industry is composed of differentiated monopolistically competitive intermediate firms.

The final nontraded output, Y^N, is produced in a competitive retail sector with constant-returns-to-scale production, which aggregates a continuum of measure one of sectoral nontraded goods.[15] We denote the elasticity of substitution between any two different sectoral goods by $\omega > 0$. In each sector, there are $N > 1$ firms producing differentiated goods that are aggregated into a sectoral nontraded good. The elasticity of substitution between any two varieties within a sector is denoted by $\epsilon > 0$, and we assume that this is higher than the elasticity of substitution across sectors, i.e., $\epsilon > \omega$ [see Jaimovich and Floetotto (2008)]. Within each sector, there is monopolistic competition; each firm that produces one variety is a price setter. Output $\mathcal{X}_{i,j}$ of firm i in sector j is produced using capital and labor, i.e., $\mathcal{X}_{i,j} = H\left(\mathcal{K}_{i,j}, \mathcal{L}_{i,j}\right)$. Each firm chooses capital and labor by equalizing

https://doi.org/10.1017/S1365100514000133 Published online by Cambridge University Press

markup-adjusted marginal products to the marginal cost of inputs; i. e., $PH_K/\mu = R$, and $PH_L/\mu = W$, where μ is the markup over the marginal costs. At a symmetric equilibrium, nontraded output is equal to $Y^N = N\mathcal{X} = H\left(K^N, L^N\right)$, where $L_N = N\mathcal{L}_N$ and $K_N = N\mathcal{K}_N$.

Following Galí (1995), we depart from the usual practice by assuming that the number of firms is large enough so that we can ignore the strategic effects but not so large that the effect of entry on the firm's demand curve is minuscule. Consequently, the price elasticity of demand faced by a single firm is no longer constant and equal to the elasticity of substitution between any two varieties, but rather is a function of the number of firms N. Taking into account the fact that output of one variety does not affect the price of final nontraded output, but influences the sectoral price level, in a symmetric equilibrium, the resulting price elasticity of demand is

$$e\left(N\right) = \epsilon - \frac{(\epsilon - \omega)}{N}, \quad N \in (1, \infty)\,. \tag{6}$$

Assuming that $\epsilon > \omega$, the price elasticity of demand faced by one single firm is an increasing function of the number of firms N within a sector. Henceforth, the markup $\mu = \frac{e}{e-1}$ decreases as the number of competitors increases, i.e., $\mu_N < 0$.

We assume instantaneous entry, which implies that the zero-profit condition holds at each instant of time:

$$\pi^N = P\left[\frac{Y^N}{N}\left(1 - \frac{1}{\mu}\right) - \psi\right] = 0, \tag{7}$$

where we denote fixed costs by ψ. The zero-profit condition $\pi^N = 0$ can be solved for the number of firms.[16]

Because inputs can move freely between the two sectors, marginal products in the traded and the nontraded sector equalize:

$$\theta^T\left(k^T\right)^{\theta^T-1} = \frac{P}{\mu}\theta^N\left(k^N\right)^{\theta^N-1} \equiv R, \tag{8a}$$

$$\left(1-\theta^T\right)\left(k^T\right)^{\theta^T} = \frac{P}{\mu}\left(1-\theta^N\right)\left(k^N\right)^{\theta^N} \equiv W, \tag{8b}$$

where we denote by $k^i \equiv K^i/L^i$ the capital–labor ratio for sector $i = T, N$,

Aggregating labor and capital over the two sectors gives us the resource constraints for the two inputs:

$$L^T + L^N = L, \quad K^T + K^N = K. \tag{9}$$

2.3. Government

The final agent in the economy is the government, which finances government expenditure by raising lump-sum taxes Z in accordance with the balanced condition

$$G^T + PG^N = Z. \tag{10}$$

Public spending consists of purchases of traded goods, G^T, and nontraded goods, G^N. Because one prominent feature of the time series of government spending is that its nontradable content is substantial, at around 90%, in the following we therefore concentrate on the effects of a rise in public purchases of nontraded goods.

2.4. Short-Run Static Solutions

System (8a)–(8b) can be solved for sectoral capital–labor ratios: $k^T = k^T(P, \mu)$ and $k^N = k^N(P, \mu)$. Using the fact that $W \equiv (1 - \theta^T)(k^T)^{\theta^T}$, the wage rate also depends on P and μ, i.e., $W = W(P, \mu)$, with $W_P \gtrless 0$, $W_\mu \lessgtr 0$. An increase in the relative price P raises or lowers W depending on whether the traded sector is more or less capital-intensive than the nontraded sector. Because a rise in μ produces effects on variables opposite to those induced by a rise in P, we concentrate on the relative price effects to save space.

Plugging sectoral capital–labor ratios into the resource constraints and production functions leads to short-term static solutions for sectoral output: $Y^T = Y^T(K, L, P, \mu)$ and $Y^N = Y^N(K, L, P, \mu)$. According to the Rybczynski effect, a rise in K raises the output of the sector that is more capital-intensive, whereas a rise in L raises the output of the sector that is more labor-intensive. An increase in the relative price of nontradables exerts opposite effects on sectoral outputs by shifting resources away from the traded sector towards the nontraded sector.

By substituting $W = W(P, \mu)$, the system (5a), (5b) can be solved for consumption and labor supply as follows: $C = C\left(\bar{\lambda}, P\right)$ with $C_{\bar{\lambda}} < 0$, $C_P < 0$ and $L = L\left(\bar{\lambda}, P, \mu\right)$ with $L_{\bar{\lambda}} > 0$, $L_P \gtrless 0$, $L_\mu \lessgtr 0$. A rise in the shadow value of wealth induces agents to cut their real expenditure and to supply more labor. By raising the consumption price index, an appreciation in the relative price of nontradables drives down consumption. Finally, depending on whether $k^T \gtrless k^N$, a rise in P stimulates or depresses labor supply by raising or lowering W.

The zero profit condition (7) can be solved for the number of intermediate producers by inserting $Y^N = Y^N\left[K, L\left(\bar{\lambda}, P, \mu\right), P, \mu\right]$ [with $\mu = \mu(N)$]. We have

$$N = N\left(K, P, \bar{\lambda}\right), \quad N_K \gtrless 0, N_P > 0, N_{\bar{\lambda}} \lessgtr 0. \tag{11}$$

Because N co-varies with nontraded output Y^N, a rise in P unambiguously stimulates entry, whereas an increase in K (resp. in $\bar{\lambda}$) raises the number of competitors N if the nontraded sector is more (resp. less) capital-intensive than the traded sector.

2.5. Macroeconomic Dynamics

We now describe the dynamics. The adjustment of the open economy toward the steady state is described by a dynamic system that comprises two equations. First, the dynamic equation for the relative price of nontraded goods (5d) equalizes the return on domestic capital and traded bonds $r^{\star}$. Second, the accumulation equation for physical capital clears the nontraded goods market along the transitional path:

$$\dot{K} = \frac{Y^N(K, L, P, \mu)}{\mu} - C^N\left(\bar{\lambda}, P\right) - G^N - \delta_K K, \qquad \textbf{(12)}$$

where $L = L\left(\bar{\lambda}, P, \mu\right)$ and $\mu = \mu\left[N\left(K, P, \bar{\lambda}\right)\right]$.

Linearizing (12) and (5d), which form a separate subsystem in K and P, and assuming that the Jacobian matrix of the differential equation system has one negative eigenvalue denoted by ν_1 and one positive eigenvalue denoted by ν_2, the general solutions for K and P are

$$K(t) - \tilde{K} = B_1 e^{\nu_1 t} + B_2 e^{\nu_2 t}, \quad P(t) - \tilde{P} = \omega_2^1 B_1 e^{\nu_1 t} + \omega_2^2 B_2 e^{\nu_2 t}, \qquad \textbf{(13)}$$

where B_1 and B_2 are constants to be determined and ω_2^i is the element of the eigenvector associated with the eigenvalue ν_i (with $i = 1, 2$). Two features of the two-sector economy's equilibrium dynamics deserve special attention. First, if the markup is fixed and the traded sector is more capital-intensive, we have to set $\omega_2^1 = 0$ to rule out unstable paths.[17] Hence, the temporal path for the real exchange rate is flat when $k^T > k^N$.[18] An endogenous markup restores dynamics for the relative price. Specifically, P and K move in opposite directions along a stable path, i.e., $\omega_2^1 < 0$. Second, when the expansionary policy is transitorily implemented (i.e., the fiscal shock only lasts for $\mathcal{T}$ periods), two periods have to be considered, namely a first period (labeled period 1) over which the temporary policy is in effect, and a second period (labeled period 2) after the policy has been removed. Although the small country converges toward its new long-run equilibrium over period 2, i.e., B_2 must be set to zero, the economy follows unstable paths over period 1. These are described by (13).

Substituting (12) and (10) into (3), we obtain the dynamic equation for the current account (denoted by CA $\equiv \dot{B}$):

$$\dot{B} = r^{\star} B + Y^T(K, L, P, \mu) - C^T\left(\bar{\lambda}, P\right) - G^T, \qquad \textbf{(14)}$$

where $Y^T - C^T - G^T$ correspond to net exports. Linearizing (14) around the steady-state and substituting (13), the general solution for the stock of foreign assets is given by:[19]

$$B(t) = \tilde{B} + \left[\left(B_0 - \tilde{B}\right) - \Phi_1 B_1 - \Phi_2 B_2\right] e^{r^{\star} t} + \Phi_1 B_1 e^{\nu_1 t} + \Phi_2 B_2 e^{\nu_2 t}. \qquad \textbf{(15)}$$

When the disturbance is temporary, we must take into account that assets (i.e., domestic capital and foreign bonds) have been accumulated (or decumulated) over the period 1. The time path for net foreign assets is described by equation (15) during this unstable period. As stocks of assets are modified over period 1 (i.e., $(0, \mathcal{T})$), we have to take new initial conditions (i.e., $B_{\mathcal{T}}$ and $K_{\mathcal{T}}$) into account when the fiscal policy is removed.

2.6. Steady State

We now discuss the salient features of the steady state. Setting $\dot{P} = 0$ into (5d) and using equality of marginal products of labor, implying $\tilde{P}/\mu(\tilde{N}) = \Psi^T/\Psi^N(\tilde{W}/\tilde{R})^{\theta^T-\theta^N}$, we find that the real exchange is positively tied to the markup:

$$\tilde{P} = \Gamma\left[\mu\left(\tilde{N}\right)\right]^{\frac{1-\theta^T}{1-\theta^N}}, \tag{16}$$

where $\Gamma > 0$ is a constant equal to $\Psi^T/(\Psi^N)^{(1-\theta^T)/(1-\theta^N)}(r^\star + \delta^K)^{-(\theta^T-\theta^N)/(1-\theta^N)}$ with $\Psi^j = (\theta^j)^{\theta^j}(1-\theta^j)^{1-\theta^j}$ $(j = T, N)$.[20] According to (16), a fall in the markup depreciates the real exchange rate in the long run.

Setting $\dot{K} = 0$ into (12) yields the market-clearing condition for the nontraded good:

$$Y^N\left[\tilde{K}, \tilde{L}, \tilde{P}, \mu\left(\tilde{N}\right)\right]/\mu\left(\tilde{N}\right) = C^N\left(\bar{\lambda}, \tilde{P}\right) + \tilde{I} + G^N, \tag{17}$$

where $\tilde{I} = \delta_K\tilde{K}$. Setting $\dot{B} = 0$ into (14) leads to the market-clearing condition for the traded good:

$$Y^T\left[\tilde{K}, \tilde{L}, \tilde{P}, \mu\left(\tilde{N}\right)\right] = -r^\star\tilde{B} + C^T\left(\bar{\lambda}, \tilde{P}\right) + G^T. \tag{18}$$

The number of firms $\tilde{N}$ is determined by the zero-profit condition:

$$Y^N\left\{\tilde{K}, \tilde{L}, \tilde{P}, \mu\left(\tilde{N}\right)\right\}\left\{1 - \left[1/\mu\left(\tilde{N}\right)\right]\right\} - \tilde{N}\psi = 0. \tag{19}$$

For the country to remain ultimately solvent, we have to impose one single and overall intertemporal budget constraint,[21]

$$B_0 - \tilde{B} = \Phi_1\left(K_0 - \tilde{K}\right), \tag{20}$$

where $\Phi_1 < 0$ describes the effect of capital accumulation on the external asset position and K_0 and B_0 are the initial conditions.[22] The five equations (16)–(20) jointly determine $\tilde{P}$, $\tilde{K}$, $\tilde{B}$, $\tilde{N}$, and $\bar{\lambda}$.

3. TEMPORARY FISCAL EXPANSION: AN ANALYTICAL EXPLORATION

In this section, we analytically explore the short-run effects of a fiscal expansion. As the shocks identified in the VAR literature are transitory, in this paper we focus the theoretical analysis on temporary increases in government spending. We suppose that at time $t = 0$, the government raises public spending on the nontraded good, and at time $\mathcal{T}$, it removes the expansionary budget policy.[23] The higher $\mathcal{T}$, the greater the persistence of the shock.[24]

Our model has two distinctive features: the two-sector dimension and imperfectly competitive product markets with endogenous markups. In assessing the ability of the model with tradables and nontradables to account for the evidence, we adopt a two-step approach. First, we emphasize how an endogenous markup produces the real exchange rate depreciation documented by the empirical literature on the effects of fiscal shocks. To do so, we derive a number of analytical results by abstracting from physical capital. We then discuss the implications of introducing physical capital in the setup. This allows us to explain how allowing endogenous markups is a necessary but not sufficient condition to produce real exchange rate depreciation. Second, because the simultaneous decline in investment and the current account is one of the most consistent responses to a fiscal shock documented in the empirical literature, we analytically assess the ability of the two-sector model to account for this finding. Because assuming countercyclical markups is not essential to produce crowding-out of investment and a current account deficit following a temporary fiscal expansion, we provide analytical results with a fixed markup by assuming that the number within each nontraded industry is large, so that the number of competitors has no effect on the markup.[25]

We first explore the implications of an endogenous markup in a two-sector open economy without physical capital; the main result is that the real exchange rate unambiguously depreciates after a temporary fiscal shock in a model abstracting from physical capital accumulation. We assume constant-returns-to-scale technology, i.e., $Y^T = L^T$ and $Y^N = L^N$. Because of perfect labor mobility across sectors, we have $1 = P/\mu = W$, where the markup $\mu = \mu(N)$ decreases as the number of competitors N increases. When free entry is imposed, the zero-profit condition can be solved for the number of firms, i.e., $N = N\left(L^N\right)$. The resource constraint for labor reads $L = L^T + L^N$. First-order conditions (5a)–(5c) hold. The nontraded-good market-clearing condition can be rewritten as $L^N/\mu = C^N + G^N$, whereas the traded-good market-clearing condition is $r^\star \tilde{B} + L^T = C^T + G^T$. The intertemporal solvency condition now reduces to $\tilde{B} = B_0$.[26]

We now investigate the effects of a temporary rise in G^N. To begin with, in a model abstracting from physical capital accumulation, all variables adjust instantaneously to their long-run levels, except the stock of foreign assets; hence, the tilde is suppressed to increase clarity. By raising (lump-sum) taxes to balance the budget and reducing households' disposable income, a fiscal expansion produces an increase in the shadow value of wealth, as shown formally by[27]

$$\left.\frac{d\bar{\lambda}}{dG^N}\right|_{\text{temp}} = \frac{P\bar{\lambda}}{Y\chi} \frac{\left[1 + \frac{\omega_C(1-\alpha_C)\alpha_C}{\omega_N}\left(\phi - \sigma_C\right)\eta_{\mu,N}\eta_{N,L^N}\right]}{\Psi}\left(1 - e^{-r^\star T}\right) > 0, \quad \textbf{(21)}$$

where $\chi < 0$, $\Psi > 0$, $\eta_{\mu,N} < 0$ is the elasticity of the markup to the number of competitors, and $\eta_{N,L^N} > 0$ is the elasticity of the number of competitors to nontraded labor.[28]

The negative wealth effect induces agents to work more and cut real expenditure. Because the decline in real expenditure is spread over the two goods, the rise in G^N more than offsets the fall in C^N, so that labor in the nontraded sector increases:[29]

$$\left.\frac{dL^N(0)}{dG^N}\right|_{\text{temp}} = -\frac{\omega_C \alpha_C \sigma_C L^N}{\bar{\lambda}\chi\omega_N}\left.\frac{d\bar{\lambda}}{dG^N}\right|_{\text{temp}} + \frac{P}{\chi} > 0. \tag{22}$$

Higher nontraded output creates profit opportunities, inducing new firms to enter the market. Hence, the markup μ unambiguously falls. Because $P = \mu\ W$ and perfect mobility of labor implies that $W = 1$, nontraded producers with market power set lower prices as they perceive more elastic demand. As a result, the real exchange rate depreciates, in line with the evidence.

Introducing physical capital implies that the real exchange rate does not necessarily depreciate. In the following, we emphasize that we have to assume that the traded sector is more capital-intensive to generate real exchange rate depreciation. Specifically, nontraded producers with market power mark up prices over the unit cost UC, i.e., $P = \mu\text{UC}$. The unit cost for producing one unit of the nontraded good is a weighted average of the rental rate of capital R and the wage rate W, i.e., $\text{UC} = R^{\theta^N} W^{1-\theta^N}/\left(\theta^N\right)^{\theta^N}\left(1-\theta^N\right)^{1-\theta^N}$. For the real exchange rate to depreciate, both the markup and the unit cost must fall, or alternatively, the decline in the markup must offset the rise in the unit cost. The adjustment in the unit cost crucially depends on sectoral capital–labor ratio changes. To see it, take the logarithm and differentiate $P = \mu\text{UC}$, and use the fact that $\hat{R} = -\left(1-\theta^T\right)\hat{k}^T$ and $\hat{W} = \theta^T\hat{k}^T$; denoting the percentage deviation from its initial steady-state by a circumflex and rearranging terms, we get

$$\hat{P} = \hat{\mu} + \left(\theta^T - \theta^N\right)\hat{k}^T, \tag{23}$$

where $\hat{k}^T = \hat{k}^N$. According to (23), the markup decline yields a real exchange rate depreciation if the capital–labor ratios k^j (with $j = T, N$) remain fixed, because in this case, the unit cost is unaffected. Although a higher labor supply lowers $k^j = K^j/L^j$ on impact, the reallocation of inputs across sectors may keep the sectoral capital–labor ratios unchanged. More precisely, although both inputs are shifted toward the nontraded sector, capital increases in relative abundance when the traded sector is more capital-intensive. In this case, for given P, the reallocation of inputs keeps capital–labor ratios k^j fixed, thus leaving the unit cost unchanged. Equation (23) implies that the fall in the markup lowers the real exchange rate. Conversely, when the nontraded sector is more capital-intensive, labor increases in relative abundance, thus further lowering the capital–labor ratios. As shown by equation (23), if $\theta^N > \theta^T$, reduced capital–labor ratios k^j raise the unit cost by raising the rental rate of capital. As a result, the real exchange rate may appreciate instead of depreciating. As discussed in the next section, we find numerically that the rise in the unit cost pushes up the real exchange rate (while the markup falls) across all scenarios when $k^N > k^T$.

We now turn to the responses of investment and the current account following a temporary fiscal expansion. In order to preserve analytical tractability, we assume that the number of competitors within each industry is large enough so that equation (6) implies that the price elasticity of demand e reduces to ϵ; in this case, the markup is fixed, i.e., $\mu = \frac{\epsilon}{\epsilon-1}$. To begin with, it should be mentioned that an endogenous markup is not a key ingredient to produce either crowding out of investment or a current account deficit.[30] The reallocation of inputs plays a key role instead in the determination of investment and the current account responses. To avoid unnecessary complications, we provide analytical results for the initial responses for investment and the current account when the traded sector is more capital-intensive than the nontraded sector.[31] Formal expressions allow us to analyze the role of the length of the fiscal shock captured by $\mathcal{T}$ and of the elasticity of labor supply σ_L.

The response of investment is the result of two opposite effects. On one hand, according to Rybczynski's theorem, a rise in labor supply raises the output of the sector which is more labor-intensive and thus stimulates investment. On the other hand, because the decline in real expenditure is spread over the two goods, the fall in C^N is not large enough to more than offset the rise in G^N, which exerts a negative effect on investment. Hence, higher public spending G^N may crowd in or crowd out capital investment. Formally, the initial reaction of investment is ambiguous:

$$\left.\frac{dI(0)}{dG^N}\right|_{\text{temp}} = -\left\{1 + \left(1 - e^{-r^\star \mathcal{T}}\right) \frac{\left[\sigma_L \tilde{L}\tilde{k}^T \tilde{P}\left(\nu_1 + \delta_K\right) - \sigma_C \tilde{P}\tilde{C}^N\right]}{\left(\sigma_C P_C \tilde{C} + \sigma_L \tilde{W}\tilde{L}\right)}\right\} \lesseqgtr 0. \tag{24}$$

When σ_L is set to 0 in (24), the reaction of investment becomes unambiguously negative, i.e., $dI(0)/dG^N = \alpha_C\left(1 - e^{-r^\star \mathcal{T}}\right) - 1 < 0$, because the rise in public spending G^N exceeds the fall in C^N. As long as $\sigma_L > 0$, the sign of (24) is no longer clear cut. The less responsive the labor supply (i.e., the smaller σ_L) or the shorter the fiscal expansion (i.e., the lower $\mathcal{T}$), the more likely it is that investment is crowded out by public spending.[32] When the fiscal shock is short-lived, the negative wealth effect is smaller, so that labor supply and hence Y^N increases less, whereas consumption of nontradables C^N falls by a smaller amount.

Turning to the initial response of the current account, we obtain after computation

$$\left.\frac{d\text{CA}(0)}{dG^N}\right|_{\text{temp}} = -\tilde{P}e^{-r^\star \mathcal{T}} + \tilde{P}\left\{1 + \left(1 - e^{-r^\star \mathcal{T}}\right) \frac{\left[\sigma_L \tilde{L}\tilde{k}^T \tilde{P}\left(\nu_1 + \delta_K\right) - \sigma_C \tilde{P}\tilde{C}^N\right]}{\left(\sigma_C P_C \tilde{C} + \sigma_L \tilde{W}\tilde{L}\right)}\right\} \lesseqgtr 0. \tag{25}$$

https://doi.org/10.1017/S1365100514000133 Published online by Cambridge University Press

The first term on the RHS of (25) represents the negative impact of reduced savings on the current account. The second term on the RHS of (25) represents the influence of investment on the net foreign asset position. When setting σ_L to zero into (25), the initial current account response, given by $d\mathrm{CA}(0)/dG^N = \tilde{P}\,(1-\alpha_C)\left(1-e^{-r^{\star}\mathcal{T}}\right)$, becomes unambiguously positive. The reason is that the decline in investment is large enough to more than offset the drop in private savings induced by the smoothing behavior. The more responsive the labor supply (i.e., σ_L is higher), the smaller the decline in investment on impact, and hence the more likely it is that the open economy experiences a current account deficit. The length of the shock $\mathcal{T}$ exerts two opposite effects on the initial response of the current account. On the one hand, as the fiscal shock is shorter (i.e., $\mathcal{T}$ becomes smaller), agents are more willing to reduce private savings, which amplifies the deterioration in the net foreign asset position. On the other hand, investment declines more, which exerts a positive effect on the current account. The overall effect will be determined numerically.

When the nontraded sector is more capital-intensive, investment is less likely to be crowded out by public spending than if $k^T > k^N$. In the latter case, the reallocation of inputs keep sectoral capital intensities fixed, so that the real exchange rate remains unaffected by the fiscal shock. Conversely, when the nontraded sector is more capital-intensive, the real exchange rate appreciates because the unit cost for producing rises. By shifting resources toward the nontraded sector, the rise in P has an expansionary effect on nontraded output and thus on investment.

4. TEMPORARY FISCAL EXPANSION: A QUANTITATIVE EXPLORATION

In this section, we quantitatively analyze the effects of a temporary rise in government spending. For this purpose we numerically solve the open economy model with endogenous markups. In the following we thus first discuss parameter values before turning to the short-term effects of the fiscal shock.

4.1. Baseline Parameterization

Because we calibrate a two-sector model with tradables and nontradables, we pay particular attention to the suitability of the nontradable content of the model to the data. Table 1 summarizes the nontradable content of GDP, employment, consumption, and government spending and gives the share of government spending on the traded and nontraded good in the sectoral output, the shares of capital income in output in both sectors, and the markup charged by the nontraded sector for all countries of our sample.[33]

We start by describing the calibration of consumption-side parameters, which we use as a baseline. The world interest rate, which is equal to the subjective time discount rate β, is set to 1%. One period of time corresponds to a quarter. The elasticity of substitution between traded and nontraded goods ϕ is set to 1.5 [see, e.g., Cashin and Mc Dermott (2003)]. The weight φ of consumption of

https://doi.org/10.1017/S1365100514000133 Published online by Cambridge University Press

TABLE 1. Data to calibrate the two-sector model (1970–2004)

	Nontradable share				G^j/Y^j		Capital share		Markup
Country	Output	Labor	Consumption	Gov. spending	G^N/Y^N	G^T/Y^T	θ^T	θ^N	μ
AUT	0.65	0.60	0.44	0.90	0.28	0.07	0.28	0.32	1.42
BEL	0.67	0.65	0.44	0.85	0.30	0.09	0.33	0.35	1.34
DEU	0.64	0.61	0.44	0.91	0.30	0.06	0.22	0.33	1.45
DNK	0.70	0.67	0.43	0.93	0.40	0.07	0.32	0.32	1.40
FIN	0.58	0.57	0.44	0.84	0.34	0.09	0.27	0.30	1.32
FRA	0.69	0.64	0.40	0.93	0.33	0.06	0.22	0.35	1.35
GBR	0.62	0.66	0.52	0.93	0.33	0.05	0.30	0.28	1.37
ITA	0.63	0.56	0.36	0.91	0.29	0.06	0.42	0.39	1.60
JPN	0.64	0.61	0.39	n.a.	n.a.	n.a.	0.37	0.29	1.51
NLD	0.67	0.69	0.45	0.91	0.34	0.08	0.41	0.33	1.32
SPA	0.61	0.59	0.50	0.90	0.25	0.05	0.35	0.26	1.33
SWE	0.65	0.67	0.51	0.90	0.43	0.09	0.30	0.30	1.31
USA	0.68	0.72	0.49	0.90	0.22	0.06	0.36	0.32	1.43

Notes: Table 1 shows the nontradable content of GDP, employment, consumption, and government spending. Table 1 also gives the share G^j/Y^j of government spending on the traded and nontraded good in the sectoral output (with $j = T, N$), the shares θ^j of capital income in output in both sectors, and the markup μ charged by the nontraded sector for 13 OECD countries. The choice of these countries has been dictated by data availability. For the countries in our sample, the period runs from 1970 to 2004. The construction and sources are detailed in a longer version of the paper, which is available at http://www.beta-umr7522.fr/productions/publications/2012/2012-17.pdf.

tradables is set to 0.5 in the baseline calibration to target a nontradable content in total consumption expenditure (i.e., α_C) of 45%, in line with our estimates. The intertemporal elasticity of substitution for consumption, σ_C, is set to 0.5 because empirical evidence overwhelmingly suggests values smaller than one. One critical parameter is the intertemporal elasticity of substitution for labor supply, σ_L. In our baseline parameterization, we set $\sigma_L = 0.5$, in line with evidence reported by Domeij and Flodén (2006).

We now describe the calibration of production-side parameters. We assume that physical capital depreciates at a rate $\delta_K = 1.5\%$ to target an investment–GDP ratio of 20%. The shares of sectoral capital income in output take two different values, depending on whether the traded sector is more or less capital-intensive than the nontraded sector. In line with our estimates, if $k^T > k^N$, θ^T and θ^N are set to 0.4 and 0.3, respectively.[34] Alternatively, when $k^N > k^T$, we choose $\theta^T = 0.3$ and $\theta^N = 0.4$. Setting the elasticity of substitution between sectoral goods, ω, to 1 and the elasticity of substitution between varieties, ϵ, to 4 yields a markup μ charged by the nontraded sector of 1.35, which is close to the 13 OECD countries' unweighted average.

We set G^N and G^T to yield a nontradable share of government spending of 90%, and government spending as a share of GDP of 20%.[35] We consider three different scenarios for the duration of the fiscal shock: a short-lived ($\mathcal{T} = 8$), a medium-lived ($\mathcal{T} = 16$), and a long-lived ($\mathcal{T} = 32$) fiscal shock. As the baseline scenario, we take the medium-lived fiscal shock, i.e., a shock that lasts 16 quarters. In this case, the cumulative increase in government spending corresponds approximately to the cumulative increase in U.S. government spending six years after an exogenous spending shock by one percentage point of GDP, according to the estimates reported by Cardi and Müller (2011). For $\mathcal{T} = 16$, we also conduct a sensitivity analysis with respect to the elasticity of labor supply (i.e., we set σ_L to 0.1 and 1).

4.2. Short-Run Effects

We now discuss the short-run effects of the fiscal expansion. We take the medium-lived spending shock as our baseline scenario, but we also refer to short-lived and long-lived fiscal shocks, as the length of fiscal stimulus may vary across countries. Panels A and B of Table 2 show the results for this situation, as well as for a number of alternative scenarios. Whereas panel A gives the response on impact, panel B displays the cumulative responses over the first two years (i.e., eight quarters) after the shock. To emphasize how an endogenous markup improves the predictive power of the two-sector model, we numerically solve the model with a fixed markup as well. Numerical results for a fixed markup are shown in the first column when $k^T > k^N$ and in the seventh column with the reversal of sectoral capital intensities.

Before analyzing in detail the role of countercyclical markups and sectoral reallocation in shaping the short-run dynamics in response to a temporary increase in

https://doi.org/10.1017/S1365100514000133 Published online by Cambridge University Press

TABLE 2. Quantitative effects of a temporary fiscal expansion (in %): The case of an endogenous markup

	$k^T > k^N$						$k^N > k^T$					
	μ fixed	Bench $\mathcal{T} = 16$			Short $\mathcal{T} = 8$	Long $\mathcal{T} = 32$	μ fixed	Bench $\mathcal{T} = 16$			Short $\mathcal{T} = 8$	Long $\mathcal{T} = 32$
Variable	$\sigma_L = 0.5$	$\sigma_L = 0.5$	$\sigma_L = 0.1$	$\sigma_L = 1$	$\sigma_L = 0.5$	$\sigma_L = 0.5$	$\sigma_L = 0.5$	$\sigma_L = 0.5$	$\sigma_L = 0.1$	$\sigma_L = 1$	$\sigma_L = 0.5$	$\sigma_L = 0.5$
A. Impact												
Consumption, $dC(0)$	−0.07	−0.07	−0.12	−0.04	−0.03	−0.12	−0.08	−0.08	−0.13	−0.06	−0.04	−0.14
RER, $dP(0)$	0.00	−0.01	−0.01	−0.01	−0.01	−0.01	0.08	0.07	0.07	0.07	0.05	0.09
Wage, $dW(0)$	0.00	−0.04	−0.05	−0.05	−0.05	−0.02	−0.25	−0.28	−0.25	−0.28	−0.22	−0.33
Real wage, $dW(0)/P_C(0)$	0.00	−0.04	−0.04	−0.05	−0.05	−0.01	−0.29	−0.32	−0.29	−0.32	−0.24	−0.38
Labor, $dL(0)$	0.12	0.09	0.04	0.09	0.03	0.21	0.00	−0.02	0.02	−0.11	−0.04	0.06
Savings, $dS(0)$	−0.85	−0.90	−0.89	−0.93	−0.98	−0.74	−1.10	−1.13	−1.04	−1.21	−1.14	−1.06
Investment, $dI(0)$	−0.66	−0.99	−1.14	−1.07	−1.22	−0.49	0.80	1.06	0.82	1.23	0.63	1.31
Current account, dCA(0)	−0.20	0.09	0.25	0.14	0.24	−0.25	−1.90	−2.19	−1.86	−2.44	−1.76	−2.36
GDP, $dY(0)$	0.08	0.06	0.03	0.06	0.02	0.14	0.00	−0.01	0.01	−0.07	−0.03	0.04
Traded output, $dY^T(0)$	−0.24	0.05	0.18	0.11	0.22	−0.33	−1.92	−2.21	−1.91	−2.46	−1.78	−2.41
NT output, $dY^N(0)$	0.32	0.01	−0.16	−0.05	−0.20	0.46	1.92	2.20	1.93	2.38	1.75	2.45
B. Cumulative response												
RER, dP	0.00	−0.11	−0.09	−0.13	−0.09	−0.13	0.42	0.29	0.28	0.26	0.22	0.35
Real wage, dW/P_C	0.00	−0.04	−0.08	−0.05	0.04	0.05	−1.47	−1.44	−1.32	−1.40	−1.06	−1.73
Investment, dI	−3.16	−3.55	−4.48	−3.27	−3.78	−1.81	3.22	4.28	3.22	5.01	−0.05	6.06
Current account, dCA	−3.91	−3.61	−2.67	−3.94	−3.87	−4.23	−11.53	−12.60	−11.15	−13.69	−8.52	−13.60
GDP, dY	0.32	0.23	−0.23	0.39	−0.09	0.97	0.69	0.78	0.58	0.68	0.22	1.41
Traded output, dY^T	−4.11	−3.84	−3.17	−4.05	−3.95	−4.70	−11.31	−12.36	−11.16	−13.31	−8.28	−13.54
NT output, dY^N	4.42	4.05	2.92	4.43	3.84	5.65	12.00	13.15	11.75	14.00	8.52	14.96

Notes: We assume a temporary rise in G^N, which raises total government spending by one percentage point of GDP. Impact deviations from initial steady state are scaled by initial GDP, with the exception of the real exchange rate, wage rate, and labor, which are scaled by their initial steady-state values. Short-lived, medium-lived, and long-lived shocka last 8, 16, and 32 quarters, respectively. NT, nontraded.

government spending, we should mention the set of empirical evidence established by Corsetti et al. (2012), which confirms earlier findings by Monacelli and Perotti (2010). Using a sample of 17 OECD countries over the period 1975–2008, it is found that an exogenous increase in government spending moderately raises output, induces a simultaneous decline in investment and the current account, and depreciates the real exchange rate. In the following, we discuss the predictions of our model for the behavior of these variables when $k^T > k^N$ and when $k^N > k^T$.

We first address the response of the real exchange rate to a temporary fiscal expansion. As shown in panel A of Table 2, P drops on impact across all scenarios, as long as the markup is endogenous and the traded sector is more capital-intensive. When $k^T > k^N$, the cumulative responses shown in panel B reveal that the real exchange rate depreciates by 0.11% for the baseline scenario, whereas P remains unaffected if the markup is fixed (see the first column). The intuition behind this result is as follows. By producing a negative wealth effect, a fiscal expansion induces agents to supply more labor, which lowers sectoral capital–labor ratios. At the same time, because resources are shifted toward the nontraded sector, whereas the traded sector is more capital-intensive, capital increases in relative abundance. As a result, the reallocation of inputs restores the sectoral capital–labor ratios to their initial values. Hence, the unit cost of producing is unaffected, so nontraded producers do not change their prices along the transitional path. Although this chain of events holds when markups are countercyclical, the shift of resources toward the nontraded sector and the resulting increase in nontraded output produces an additional channel through which government spending influences the real exchange rate. More precisely, because a temporary fiscal shock has an expansionary effect on nontraded output, profit opportunities trigger firm entry, which reduces the markup and thus induces nontraded producers to set lower prices. Consequently, if the traded sector is more capital-intensive and the markup is endogenous, the real exchange rate depreciates in all scenarios following a fiscal expansion, as shown in panel B of Table 2.

Conversely, whether the markup is fixed or endogenous, the real exchange rate appreciates when $k^N > k^T$, as shown in panel A and panel B of Table 2. In this case, resources move toward the nontraded sector, whereas the traded sector is more labor-intensive. Because labor increases in relative abundance, sectoral capital–labor ratios fall. The rental rate of capital and thus the unit cost of producing rises, which induces nontraded producers to set higher prices. Hence, the real exchange rate appreciates in this configuration, although the markup falls when μ is endogenous.

We now turn to the output effects of a fiscal expansion. Although employment and thus GDP increases in all the scenarios where $k^T > k^N$, labor supply and output rise slightly or decrease when the sectoral capital intensities are reversed. The reason is that when $k^T > k^N$, agents are induced to supply more labor as a result of the wealth effect. In contrast, when $k^N > k^T$, the appreciation of the real exchange rate drives down the wage rate by reducing sectoral capital–labor ratios, which in turn counteracts the wealth effect. When the output effect in the case of an endogenous markup is contrasted with that in the case of a fixed markup, panel A of Table 2 shows that a countercyclical markup moderates the increase in GDP. The reason is that sectoral capital–labor ratios fall slightly when $k^T > k^N$ and drop dramatically if $k^N > k^T$.[36] Hence, with an endogenous markup, the wage rate declines, regardless of sectoral capital intensities, which in turn moderates the rise in labor supply, and thus the expansionary effect on GDP.

In line with our theoretical predictions, we find numerically that the short-run response of investment depends heavily on sectoral capital intensities. On impact, an increase in G^N crowds out investment only if the traded sector is more capital-intensive. In this case, although nontraded output expands as a result of the increase in labor supply, the rise in public spending G^N produces an excess of demand that must be eliminated by a drop in investment. As shown in the seventh line of panel A of Table 2, the less elastic labor supply is, the larger the crowding-out of investment. Moreover, as discussed in Section 3, when the length of the fiscal shock increases (i.e., $\mathcal{T}$ is greater), consumption falls more because the negative wealth effect is larger, so that investment declines less. For $k^T > k^N$, the cumulative responses reported in the third line of panel B of Table 2 show that a fiscal expansion crowds out investment by 3.16% of initial GDP if the markup is fixed and by 3.55% if the markup is endogenous. The larger drop in investment when markups are countercyclical stems from the real exchange rate depreciation, which exerts a negative impact on nontraded output and thus on physical capital accumulation.

In contrast, if the nontraded sector is more capital-intensive, the increase in G^N triggers an appreciation in the relative price of nontradables, P, which stimulates Y^N and hence investment in all scenarios. The cumulative responses reported in the third line of panel B of Table 2 show that a fiscal expansion crowds in investment by 3.22% if the markup is fixed and 4.28% of initial GDP if the markup is endogenous. A countercyclical markup amplifies the rise in investment following a fiscal shock when $k^N > k^T$ because the entry of new firms induces nontraded producers to raise output further (i.e., Y^N rises more) as they perceive a more elastic demand.

As shown in the eighth line of panel B of Table 2, the open economy experiences a current account deficit, regardless of sectoral capital intensities.[37] In both cases, agents smooth consumption by reducing private savings, which in turn deteriorates the net foreign asset position. When $k^T > k^N$, the decline in the current account triggered by the fall in savings is moderated by the drop in investment. The current account deficit after two years shrinks from 3.91% with a fixed markup of initial GDP to 3.61% with an endogenous markup, because in the latter case, investment falls more. As shown in panel B of Table 2, in line with our theoretical predictions, the more responsive the labor supply is, the larger the current account deficit. Moreover, although analytically, increasing the length of the fiscal shock captured by $\mathcal{T}$ has an ambiguous effect on the size of the current account deficit because it moderates the decline in both savings and investment, numerical results reveal that the latter effect predominates, so that the net foreign asset position deteriorates more when $\mathcal{T}$ is raised from $\mathcal{T} = 16$ to $\mathcal{T} = 32$.[38] When the nontraded sector is more capital-intensive, as shown in panel B of Table 2, the open economy runs a substantial current account deficit as savings fall while investment rises.

We have also computed the impact and cumulative responses of the real consumption wage, i.e., W/P_C. The analysis of the adjustment of the real wage is of particular interest because a number of empirical studies, specifically Perotti (2007) and Pappa (2009) for the United States and Benetrix (2012) for eleven euro area countries, find that the real consumption wage increases following a rise in government spending, whereas the standard one-sector open economy model predicts the opposite. The reason is that agents supply more labor, which lowers the capital–labor ratio and therefore the real wage. In contrast, a two-sector neoclassical model may produce an increase in the real consumption wage because of the combined effect of the reallocation of inputs and of a countercyclical markup. To see this, let us assume that the traded sector is more capital-intensive. In this configuration, the reallocation of inputs prevents the wage rate from decreasing by keeping the sectoral capital–labor ratios fixed for a given P. Moreover, by producing a real exchange rate depreciation and thus a fall in the consumption price index, a decline in the markup may push up the real consumption wage. In contrast, when the nontraded sector is more capital-intensive, a fiscal shock unambiguously lowers the real consumption wage by reducing the wage rate W and appreciating the real exchange rate.

In the light of our earlier discussion, we concentrate on the most interesting case, $k^T > k^N$. As shown in the fourth line of panel A of Table 2, if the traded sector is more capital-intensive, the decline in the wage rate more than offsets the drop in the consumption price index, so that the real consumption wage decreases on impact in all scenarios. Although the reallocation of inputs keep capital–labor ratios k^j fixed for given P, the real exchange rate depreciation induces a shift of resources toward the traded sector, thus reducing k^j. Although the capital–labor ratios fall by a small amount, the consecutive drop in W is large enough to drive down the real wage. The second line of panel B shows that the two-year horizon cumulative response of the real wage is negative for the baseline scenario. Only if the fiscal shock is short-lived or long-lived (i.e., G^N is raised over 8 or 32 quarters) does the cumulative response of the real wage become positive, as displayed in the second line of panel B of Table 2. After a long-lived fiscal shock, both nontraded output expansion and, as a consequence, firm entry are larger. Hence, the decline in the markup is large enough to produce a positive cumulative response of the real wage. Following a short-lived fiscal shock, the real exchange rate appreciates rapidly after its short-term depreciation, and it has a positive impact on the wage rate by raising the capital–labor ratios.

The last dimension of the fiscal policy transmission that our model highlights is the sectoral effects of a rise in government spending. Only a few previous studies have estimated the effects of a boost to government spending on sectoral outputs. Among these, Benetrix and Lane (2010) find that fiscal spending shocks generate a shift in the sectoral composition of output, as public purchases disproportionately benefit the nontraded sector. As summarized in the last two lines of panels A and B of Table 2, across all the scenarios, we find numerically that a rise in government spending boosts nontraded output, more so if the nontraded sector is more capital-intensive.

4.3. Transitional Adjustment

We now discuss the dynamic effects. The transitional paths of key variables under the baseline and alternative scenarios are displayed in Figure 1. The responses of GDP, investment, and current account are expressed as a percentage of the initial steady-state output, whereas the real exchange rate and the real wage are given as percentage deviations from the initial steady state. Horizontal axes measure quarters. The solid line gives results for an endogenous markup and the dashed line for a fixed markup.

The transitional paths of investment are quite distinct, depending on whether the traded sector is more or less capital-intensive than the nontraded sector. Along the transitional path, capital accumulation clears the nontraded good market. When $k^T > k^N$, the size of the crowding-out of investment falls over time, but when $k^N > k^T$, investment decreases monotonically as the depreciation in the relative price P (after its initial appreciation) lowers nontraded output. After about two years, the investment flow becomes negative and the open economy decumulates physical capital until the fiscal policy is removed. At time $\mathcal{T}$, government spending G^N reverts back to its initial level, which releases resources for capital accumulation. Regardless of sectoral capital intensities, investment is crowded in.

The temporal path for GDP is driven by the adjustments in both labor and capital. In the case $k^T > k^N$, because labor increases less when the markup is endogenous than when the markup is fixed, GDP rises by a smaller amount on impact. The dynamics for GDP is the mirror image of capital accumulation: the slowdown in GDP growth as government spending is raised originates from the crowding out of investment. In contrast, when $k^N > k^T$, the temporal path of output is hump-shaped: GDP growth first increases as labor supply rises, and then slows down as a result of the negative investment flow, which starts after about two years. At the time the fiscal policy is removed, the economy experiences an investment boom, which boosts GDP in both cases when the markup is fixed.

Regardless of sectoral capital intensities, the current account stays in deficit while government spending is raised. In the case $k^T > k^N$, the decumulation of foreign bonds reflects the negative impact of consumption smoothing behavior on the current account, even though the crowding out of investment counteracts this effect. If the sectoral capital intensities are reversed, the depreciation in the relative price of nontradables reduces investment, which exerts a positive impact on the current account. Yet in the latter case, the current account deficit at a horizon of two years is almost three times larger than if $k^T > k^N$, as shown in the fourth line of panel B of Table 2.

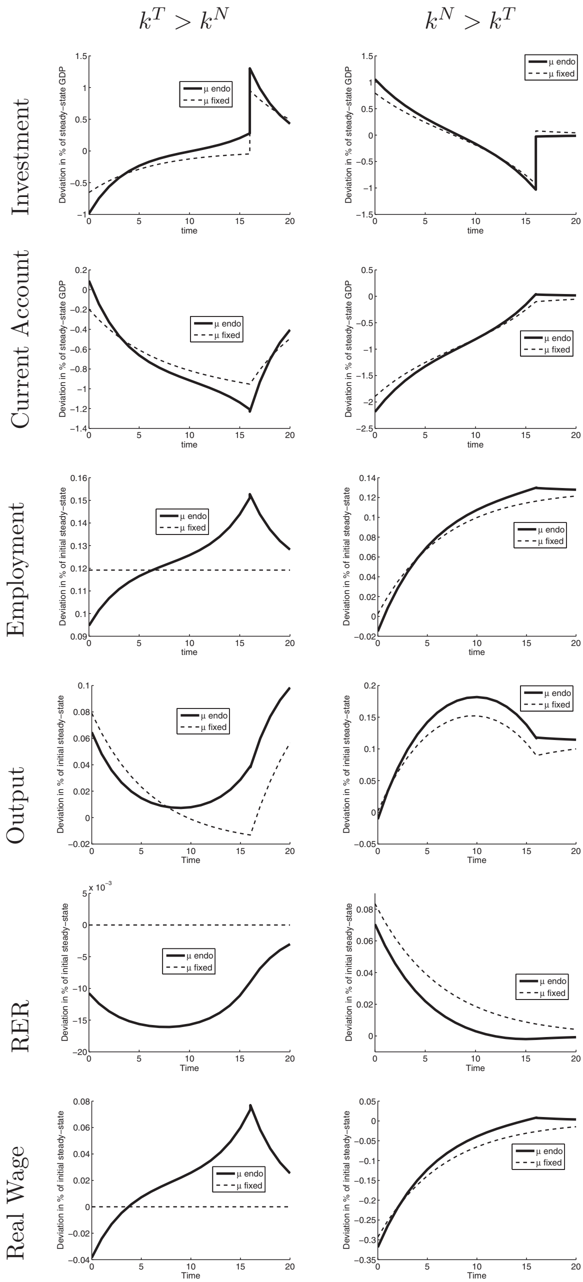

FIGURE 1. Effect of government spending shocks. Variables are measured in percentage points of output, with the exception of employment, the real exchange rate, and the real consumption wage, which are scaled by their initial steady-state values. The solid line shows results for an endogenous markup and the dashed line for a fixed markup.

https://doi.org/10.1017/S1365100514000133 Published online by Cambridge University Press

As shown in the fifth row of Figure 1, if the traded sector is more capital-intensive, the real exchange rate falls when the markup is endogenous, whereas the dynamics for P degenerates when the markup is fixed. In the former case, the dynamics of the real exchange rate is U-shaped.[39] When $k^T > k^N$, the fifth row of Figure 1 indicates that the real exchange appreciates after eight quarters, but P remains below its initial level. As displayed in the last row of Figure 1, although the real exchange rate depreciation is not large enough to push the real wage on impact, the dynamic path for W/P_C reveals that it increases along the transitional path and exceeds its initial level after about six quarters.[40]

5. CONCLUSION

A robust conclusion emerging from empirical papers is that government spending tends to depreciate the real exchange rate and to crowd out both investment and the current account. In this paper, we build a neoclassical model with countercyclical markups that can simultaneously match all these facts. We show that the open economy version of the two-sector neoclassical model with traded and nontraded goods can account for the empirical evidence on the effects of fiscal shocks, but only if markups are endogenous and the traded sector is more capital-intensive than the nontraded sector. Although both ingredients are essential to account for the real exchange rate depreciation, only the second ingredient is necessary to account for the simultaneous decline in investment and the current account.

We also find that our model may produce the positive response of the real wage documented by Perotti (2007) for the United States and more recently by Benetrix (2012), who use a sample of eleven euro area countries. In our model, the rise in the real consumption wage stems from the real exchange rate depreciation, which lowers the consumption price index while the wage rate falls by a small amount. Our numerical results reveal that the real consumption wage increases only if the fiscal shock is short- or long-lived, not if it holds for the medium term.

In conclusion, we must stress a number of caveats. If the nontraded sector is assumed to be the more capital-intensive sector, the model fails to match the evidence along a number of dimensions. Notably, in this case, the two-sector model cannot account for the crowding out of investment, which is one of the most consistent responses to a fiscal shock documented in the empirical literature. Additionally, if the traded sector is more capital-intensive than the nontraded sector, the model fails to produce a positive cumulative response of the real wage in the baseline scenario. We believe that allowing for imperfect mobility of labor across sectors, along the lines of Horvath (2000), might solve these two puzzles. The difficulty in reallocating labor should produce a rise in sectoral capital–labor ratios because the nontraded sector experiences a small labor inflow if the cost of shifting is high enough, regardless of sectoral capital intensities. Higher sectoral capital–labor ratios lower the return of domestic capital and raises the wage rate. As a result, investment should fall, whereas the real consumption wage should rise.

https://doi.org/10.1017/S1365100514000133 Published online by Cambridge University Press

NOTES

1. Hall (2009) compares the predictions of the neoclassical model with those derived from a New Keynesian framework.

2. See, e.g., Heijdra (1998), who considers a closed economy framework with monopolistic competition, and Karayalçin (2003), Cardi (2010), and Heijdra and Ligthart (2010), who use variants of the open economy version of the Baxter and King (1993) one-sector model with recursive preferences, habit formation, and finitely lived households, respectively.

3. Corsetti et al. (2012) use a sample of 17 OECD countries over the period 1975–2008, whereas Monacelli and Perotti (2010) consider a sample of four countries (Australia, Canada, United Kingdom, United States) over the period running from 1980:1 to 2006:4. Monacelli and Perotti (2010) find real exchange rate depreciation for Australia, the United States, and the United Kingdom. Enders et al. (2011) corroborate this conclusion for the United States, whereas Corsetti et al. (2012) confirm this finding for countries with floating exchange rate regimes.

4. The intuition behind Monacelli and Perotti's (2010) result is as follows. The authors assume that prices are sticky, so that a rise in government spending induces a shift in the labor demand curve, because firms have to adjust quantities in the face of a demand increase. As a result, the real wage rises. Because the authors allow for nonseparability in preferences between consumption and leisure, consumption is increasing with the wage rate, although under certain conditions. Under complete markets, consumption risk sharing implies that the ratio of marginal utilities of consumption is tied to the real exchange rate. By reducing the marginal utility, the rise in consumption produces a fall in domestic prices relative to foreign prices.

5. We follow Jaimovich and Floetotto (2008) in allowing the markup to be endogenous. This setup is a multisector extension of Linnemann's (2001) model of an endogenous markup. Considering that only a limited number of intermediate good producers operate in the nontraded sector, the price elasticity of demand and therefore the markup faced by each firm depends on the number of competitors.

6. Note that we focus on the effects of a rise in public purchases of nontraded goods, because time series of government spending indicate that its nontradable content is substantial, at around 90%.

7. The substantial increase in nontraded output following a rise in government spending is in line with the evidence documented by Benetrix and Lane (2010), who find that the relative size of the nontraded sector increases disproportionately after a temporary fiscal shock.

8. The unit cost function is a weighted average of the wage rate and the rental rate of capital. A fall in sectoral capital–labor ratios has opposite effects on cost components, as it raises the rental rate of capital and lowers the wage rate. The latter effect more than offsets the former when the traded sector is more capital-intensive, so that a fall in sectoral capital–labor ratios lowers the unit cost for producing.

9. Although both inputs are reallocated toward the nontraded sector, it is only when the traded sector is more capital-intensive that capital increases in relative abundance.

10. To produce a fall in investment, the fiscal expansion must be temporary in order to induce agents to reduce their savings.

11. More details on the model, as well as the derivations of the results that are stated later, are provided in a longer version of the paper with a Technical Appendix available at http://www.beta-umr7522.fr/productions/publications/2012/2012-17.pdf.

12. As stressed by Turnovsky and Sen (1995), allowing for traded capital investment would not affect the results (qualitatively). Furthermore, like Burstein et al. (2004), we find that the nontradable content of investment accounts for a significant share of total investment expenditure (averaging about 60%).

13. The price of the traded good is determined on the world market and exogenously given for the small open economy.

14. Specifically, we have $\alpha_C = \frac{(1-\varphi)P^{1-\phi}}{\varphi+(1-\varphi)P^{1-\phi}}$. Note that α_C depends negatively on the relative price P as long as $\phi > 1$.

https://doi.org/10.1017/S1365100514000133 Published online by Cambridge University Press

15. This setup builds on Jaimovich and Floetotto's (2008) framework. Details of its derivation are therefore relegated to the Technical Appendix of the longer version of the paper.

16. We assume instantaneous entry, because the case of no entry merely affects the results. In a longer version of the paper, we provide analytical and numerical results when no entry is imposed.

17. With a fixed markup, if $k^T > k^N$, the temporal path for the relative price must be flat for the no-arbitrage condition (5d) to be fulfilled. To see this, suppose that higher demand for nontradables pushes up the price of nontraded goods relative to traded goods, i.e., P rises. The real exchange rate appreciation produces a shift of resources toward the nontraded sector. Because the traded sector is more capital-intensive, capital increases in relative abundance, thus raising the sectoral capital–labor ratios. Hence, the return on domestic capital R falls, thus requiring that $\dot{P} > 0$. A further increase in P raises $k^j \equiv K^j/L^j$ more, which lowers the return on domestic capital and thus requires that $\dot{P} > 0$. Hence, the real exchange rate moves away from its steady-state value. To avoid such unstable paths, we have to set $\omega_2^1 = 0$. This point is emphasized by Turnovsky and Sen (1995).

18. Intuitively, as will become clear later, agents respond to a temporary fiscal expansion by raising labor supply, which lowers sectoral capital–labor ratios k^j. At the same time, because resources are shifted toward the nontraded sector when the traded sector is more capital-intensive, capital increases in relative abundance. Such a reallocation of inputs restores the capital–labor ratios to their initial values. As a result, both the wage rate and the rental rate of capital are unaffected, and so is the unit cost for producing. Consequently, nontraded producers do not change their prices. Hence, when the markup is fixed and the traded sector is more capital-intensive, a fiscal shock has no effect on the real exchange rate.

19. To avoid unnecessary complications, we give analytical expressions for Φ_i (with $i = 1, 2$) when a fixed markup is assumed. If $k^T > k^N$, we have $\Phi_1 = -\frac{\tilde{P}\nu_2}{r^\star - \nu_1} < 0$ and $\Phi_2 = -\frac{\tilde{P}\nu_1}{r^\star - \nu_2}\{1 + \frac{\omega_2^2}{\tilde{P}\nu_1}[\sigma_C \tilde{C}^N - \sigma_L \tilde{L}\tilde{k}^T(\nu_1 + \delta_K)]\}$. If $k^N > k^T$, we have $\Phi_1 = -\frac{\tilde{P}\nu_2}{r^\star - \nu_1}\{1 + \frac{\omega_2^1}{\tilde{P}\nu_2}[\sigma_C \tilde{C}^N - \sigma_L \tilde{L}\tilde{k}^T(\nu_2 + \delta_K)]\}$ and $\Phi_2 = -\frac{\tilde{P}\nu_1}{r^\star - \nu_2}$.

20. Setting $\dot{P} = 0$ yields $\tilde{R} = \tilde{P}(r^\star + \delta_K)$, which can be solved for $\tilde{k}^T$ using (8a). Inserting the solution for $\tilde{k}^T$ into equation (8b) yields $\tilde{W} = (\Psi^T)^{1/(1-\theta^T)}[\tilde{P}\left(r^\star + \delta^K\right)]^{-\theta^T/(1-\theta^T)}$. Computing and inserting the ratio $\tilde{W}/\tilde{R}$ into $\tilde{P}/\mu(\tilde{N}) = \Psi^T/\Psi^N(\tilde{W}/\tilde{R})^{\theta^T - \theta^N}$, and solving for $\tilde{P}$ yields (16).

21. By first substituting the short-run solutions, then linearizing the dynamic equation of the internationally traded bonds (14) in the neighborhood of the steady-state, substituting the solutions for $K(t)$ and $P(t)$, and finally invoking the transversality condition, we obtain the linearized version of the nation's intertemporal budget constraint (20).

22. Because, for all parameterizations, Φ_1 is always negative, we assume $\Phi_1 < 0$ from now on. Hence, capital accumulation deteriorates the current account along the transitional path.

23. We assume further that at the outset all agents perfectly understand the temporary nature of the policy change. Hence, at time $\mathcal{T}$, there is no new information and thus no jump in the marginal utility of wealth.

24. To derive formal solutions after a temporary fiscal shock, we applied the procedure developed by Schubert and Turnovsky (2002).

25. Unfortunately, a two-sector model with endogenous markups and physical capital accumulation is analytically intractable.

26. Although $\tilde{B}$ remains unaffected after permanent fiscal shocks, a temporary rise in G^N unambiguously lowers $\tilde{B}$ in the long run.

27. The term $\Psi \equiv \sigma_L + \sigma_C(1-\alpha_C)\omega_C + \frac{\alpha_C\omega_C\sigma_C}{\chi}[1 + \frac{(1-\alpha_C)\omega_C}{\omega_N}\alpha_C(\phi - \sigma_C)\eta_{\mu,N}\eta_{N,L^N}] > 0$, with $\chi = 1 - \eta_{\mu,N}\eta_{N,L^N}\{1 - \frac{\alpha_C\omega_C}{\omega_N}[(1-\alpha_C)\phi + \alpha_C\sigma_C]\} > 0$, is a function of $\eta_{\mu,N} < 0$, $\eta_{N,L^N} > 0$, the ratio of consumption expenditure to GDP ($\omega_C = \frac{P_C C}{Y}$), and the ratio of nontraded output less fixed costs to GDP ($\omega_N = \frac{PY^N/\mu}{Y} = \frac{L^N}{L}$). Note that Ψ and χ are positive as long as the markup is not too responsive to the entry of firms, i.e., $\eta_{\mu,N} < 0$ is not too large. This condition always holds for reasonable values of the markup μ.

https://doi.org/10.1017/S1365100514000133 Published online by Cambridge University Press

28. Because the increase in G^N is only temporary, the present value of the tax increases necessary to satisfy the government's intertemporal budget constraint is less than that of an equal but permanent increase in G^N, as captured by the scaling-down term $0 < (1 - e^{-r^\star \mathcal{T}}) < 1$ in equation (21).

29. The positive influence of higher G^N on L^N is captured by the second term on the RHS of (22). Because the wealth effect is smaller after a temporary rise in G^N than after a permanent fiscal shock, the first term on the RHS of (22) is less negative and hence L^N increases more in the former case (because C^N falls less).

30. When discussing numerical results in the next section, we emphasize how an endogenous markup modifies the responses of investment and the current account. As will become clear later, the fall in the markup plays a secondary role in the adjustment of investment and the current account.

31. Analytical results when $k^N > k^T$ can be found in the longer version of the paper.

32. More precisely, when $\mathcal{T}$ is smaller than the critical date $\hat{\mathcal{T}} = -\frac{1}{r^\star} \ln[\frac{(\sigma_C \tilde{C}^T - \sigma_L \tilde{L} \tilde{k}^N \tilde{P} \nu_2)}{(\sigma_L \tilde{L} \tilde{k}^T \tilde{P}(\nu_1 + \delta_K) - \sigma_C \tilde{P} \tilde{C}^N)}]$, investment is crowded out by public spending.

33. Our sample covers 13 OECD economies over the period 1970–2004. Targeted ratios for calibration are the 13 OECD countries' unweighted averages.

34. Table 1 gives the values of θ^j $(j = T, N)$. The values of θ^T and θ^N we have chosen correspond roughly to the averages for countries with $k^T > k^N$. For these values, the nontradable content of GDP and labor are 63% and 66%, respectively. When $k^N > k^T$, we can use reverse but symmetric values for θ^N, so that the size of $k^T - k^N$ remains unchanged. For $\theta^T = 0.3$ and $\theta^N = 0.4$, the nontradable content of GDP and labor is 69% and 65%, respectively.

35. Close to the average of the values reported in Table 1, the ratios G^T/Y^T and G^N/Y^N are 6% and 28% in the baseline calibration.

36. It should be mentioned that when the traded sector is more capital-intensive, sectoral capital–labor ratios fall only if the markup is endogenous; $k^j \equiv K^j/L^j$ remain unaffected if the markup is fixed. More precisely, for given P, the reallocation of inputs keeps k^j unchanged. Because P falls with an endogenous markup, resources move toward the traded sector; capital–labor ratios k^j drop by a small amount, though.

37. It is worth noting that the current account begins to show a surplus on impact when the markup is endogenous, whereas the current account falls immediately if the markup is fixed, as shown in panel A of Table 2. The reason is that in the former case, investment falls dramatically. However, the current account deteriorates rapidly.

38. Cardi and Müller (2011) provide point estimates for GDP, investment, and current account responses after an exogenous increase in government spending by one percentage point of GDP. When comparing our results when $k^T > k^N$ (panel B of Table 2) with the numbers reported by Cardi and Müller (2011), we find that our two-sector model tends to overpredict both the crowding out of investment and the current account deficit, whereas it predicts the GDP response pretty well.

39. The reason is as follows. The real exchange rate depreciation shifts resources toward the traded sector. Because the nontraded sector is more labor-intensive, the sectoral capital–labor ratios fall, which in turn raises the return on domestic capital. According to (5d), for the no-arbitrage condition to hold, the real exchange rate must decline over time, i.e., $\dot{P}/P < 0$. However, the fall in μ exerts opposite effects on R. At a certain date, the decline in the markup is large enough to offset the impact of the relative price on the return of capital.

40. Although the initial fall in the real consumption wage does not conform to the findings of Perotti (2007) and Benetrix (2012), it should be mentioned that the dynamics for W/P_C accommodates pretty well the evidence documented by Ramey (2011), who finds that the real wage falls on impact, rises along the transitional path, and exceeds its initial level after four or eight quarters, depending on the period considered.

REFERENCES

Baxter, Marianne and Robert G. King (1993) Fiscal policy in general equilibrium. *American Economic Review* 83(3), 315–334.

https://doi.org/10.1017/S1365100514000133 Published online by Cambridge University Press

Benetrix, Agustin S. (2012) Fiscal shocks and real wages. *International Journal of Finance and Economics* 17(3), 203–220.

Benetrix, Agustin and Philip R. Lane (2010) Fiscal shocks and the sectoral composition of output. *Open Economies Review* 21(3), 335–350.

Burnside, Craig, Martin Eichenbaum, and Jonas D.M. Fisher (2004) Fiscal shocks and their consequences. *Journal of Economic Theory* 115, 89–117.

Burstein, Ariel T., João C. Neves, and Sergio Rebelo (2004) Investment prices and exchange rates: Some basic facts. *Journal of the European Economic Association* 2(2–3), 302–309.

Cardi, Olivier (2010) A note on the crowding-out of investment by public spending. *Macroeconomic Dynamics* 14(4), 604–615.

Cardi, Olivier and Gernot Müller (2011) Habit formation and fiscal transmission in open economies. *Journal of International Economics* 85, 256–267.

Cashin, Paul and John C. McDermott (2003) Intertemporal substituion and terms-of-trade shocks. *Review of International Economics* 11(4), 604–618.

Corsetti, Giancarlo, André Meier, and Gernot J. Müller (2012) What determines government spending multipliers? *Economic Policy* 27(72), 521–565.

Coto-Martinez, Javier and Huw Dixon (2003) Profits, markups and entry: Fiscal policy in an open economy. *Journal of Economic Dynamics and Control* 27(4), 573–597.

Domeij, David and Martin Flodén (2006) The labor-supply elasticity and borrowing constraints: Why estimates are biased. *Review of Economic Dynamics* 9, 242–262.

Enders, Zeno, Gernot Müller, and Almuth Scholl (2011) How do fiscal and technology shocks affect real exchange rates? New evidence for the United States. *Journal of International Economics* 83, 53–69.

Galí, Jordi (1995) Product diversity, endogenous markups, and development traps. *Journal of Monetary Economics* 36, 39–63.

Galí, Jordi, J. David López-Salido, and J. Vallés (2007) Understanding the effects of government spending on consumption. *Journal of the European Economic Association* 5 227–270.

Hall, Robert E. (2009) By how much does GDP rise if the government buys more output? *Brookings Papers on Economic Activity* Fall, 183–231.

Heijdra, Ben (1998) Fiscal policy multipliers: The role of monopolistic competition, scale economies, and intertemporal substitution in labour supply. *International Economic Review* 39, 659–696.

Heijdra, Ben and Jenny E. Ligthart (2010) The transitional dynamics of fiscal policy in small open economies *Macroeconomic Dynamics* 14(1), 1–28.

Horvath, Michael (2000) Sectoral shocks and aggregate fluctuations. *Journal of Monetary Economics* 45, 69–106.

Jaimovich, Nir and Joseph Floetotto (2008) Firm dynamics, markup variations and the business cycle. *Journal of Monetary Economics* 55, 1238–1252.

Karayalçin, Cem (2003) Habit formation and government spending in a small open economy. *Macroeconomic Dynamics* 7(3), 407–423.

Linnemann, Ludger (2001) The price index effect, entry, and endogenous markups in a macroeconomic model of monopolistic competition. *Journal of Macroeconomics* 23, 441–458

Monacelli, Tommaso and Robert Perotti (2010) Fiscal policy, the real exchange rate and traded goods. *Economic Journal* 120, 437–461.

Pappa, Evi (2009) The effects of fiscal shocks on employment and the real wage. *International Economic Review* 50, 217–244.

Perotti, Roberto (2007) In Search of the Transmission Mechanism of Fiscal Policy. NBER working paper 13143.

Ramey, Valerie A. (2011) Identifying government spending shocks: It's all in the timing. *Quarterly Journal of Economics* 126(1), 1–50.
Schubert, Stefan F. and Stephen J. Turnovsky (2002) The dynamics of temporary policies in a small open economy. *Review of International Economics* 10(4), 604–622.
Turnovsky, Stephen J. and Partha Sen (1995) Investment in a two-sector dependent economy. *Journal of the Japanese and International Economies* 9, 29–55.

https://doi.org/10.1017/S1365100514000133 Published online by Cambridge University Press