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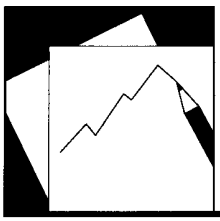

IMF Working Paper

Tax Reforms, "Free Lunches", and "Cheap Lunches" in Open Economies

Giovanni Ganelli and Juha Tervala

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Tax Reforms, "Free Lunches", and "Cheap Lunches" in Open Economies

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Abstract

This paper focuses on the macroeconomic and budgetary impact of tax reforms in a New Keynesian two-country model. Our results show that both income and consumption unilateral tax rate reductions do not constitute a "free lunch", in the sense that they have negative budgetary consequences for the country which implements them. In addition, the degree of self-financing implied by our model is in the 8½-24 percent range. Since the degree of self-financing estimated in previous literature was larger, we conclude that in our model not only the "lunch" is not "free", but is also not that "cheap". A comparison of alternative (income-tax versus consumption-tax based) fiscal stimulus packages shows that consumption tax cuts imply a larger short-run impact on domestic output but the income tax cuts stimulate the domestic economy more in the long run. We also look at the implications of a revenue-neutral tax reform in which consumption taxes are increased to compensate for lower income tax collection.

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I. INTRODUCTION

The debate on whether tax cuts can pay for themselves is often associated with the idea, popularized in the 1980s, of the Laffer curve. The original Laffer argument was that there is, at any given point in time, a hump-shaped relationship between the tax rate and actual revenue collection. Later academic and policy discussions have extended this concept in a dynamic sense. While the precise meaning of a dynamic Laffer curve is open to interpretation and various definitions have been used in the literature, a minimum necessary condition for dynamic Laffer effects to happen is that a tax cut today will increase growth and, at some point in the future, deliver higher tax revenues in the absence of other policy changes.[2] In reality, the idea that this might be possible pre-dates the Laffer debate and goes back at least to Keynes, who stated that: *"Nor should the argument seem strange that taxation may be so high as to defeat its object, and that, given sufficient time to gather the fruits, a reduction of taxation will run a better chance than an increase of balancing the budget."* (Keynes 1933; p.5).

In more recent years, Auerbach (2005) has stressed that the methodology used by the US Joint Committee on Taxation (JCT) to forecast the revenue impact of legislation changes is a partial equilibrium one, in the sense that it takes nominal GDP and other macro aggregates as given. Auerbach (2005) argues that such practice, by ruling out the possibility of a positive response of economic activity to tax reductions, biases the legislative process against tax cuts. To overcome this problem, he suggests that the JCT should adopt a general equilibrium methodology, in which feedback effects from taxes to other macroeconomic variables are taken into account.[3] Outside the US, as noted by Keen, Kim and Varsano (2006), much of the rhetoric in countries which have implemented so called "flat tax" reforms has been concerned more with the rate reduction aspect of the reform than with flatness itself. From this point of view, a main drive behind the recent wave of flat taxes has been the idea that tax cuts would provide a "free lunch" by self-financing themselves.[4]

Beside the question of the budgetary impact, another important aspect of tax reforms is related to their open economy dimension. In their Harry G. Johnson Lecture, Frenkel and Razin (1989) argued that, due to the increased integration of world capital markets and its

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[2] If this minimum necessary condition is not satisfied, none of the various definitions of dynamic Laffer effects used in the literature (see, for example, Ireland (1994), p. 563; Novales and Ruiz (2002), p. 188) can be satisfied.

[3] The partial equilibrium methodology used by the JCT is also referred to as *static scoring*, while the alternative general equilibrium methodology is also referred to as *dynamic scoring*.

4 While the term "flat tax" has been used loosely and the various versions which have been adopted (most notably by Russia and by other countries in Central and Eastern Europe) vary widely, common features have often been both a reduction of the number of income tax brackets and a substantial reduction in tax rates. See Keen, Kim and Varsano (2006) for an interesting analysis of recent "flat tax" experiences.

effects on policy interdependence between countries, a proper analysis of the implications of tax reforms should be carried out within a global open-economy framework. This statement, which was without doubt already true when the Lecture was delivered, is all the more valid in relation to today's highly globalized world economy, in which tax competition and highly mobile factors of production need to be factored in by national authorities in their tax policy decisions.

In this paper we aim at jointly analyzing the two important dimensions of tax reforms discussed above, by focusing on the domestic and international budgetary impact of unilateral income and consumption tax cuts. In doing so, we use a New Keynesian two-country model with imperfect competition and nominal rigiditities. Our model falls in to the so-called New Open Economy Macroeconomics strand of the literature.[5]

Our results show that, for a standard parameterization, dynamic Laffer effects do not emerge in our model. Both income and consumption unilateral tax rates reductions have negative budgetary consequences for the country which implements them. In addition to studying whether tax cuts can pay for themselves and be a "free lunch" for the budget, we also study whether they can be largely self-financing—in the sense of Mankiw and Weinzierl (2006)—and therefore result at least in a "cheap lunch". We find that the degree of self-financing of income tax cuts in real terms is about 17 percent in our benchmark parameterezation and is in the 13-24 percent range in the sensitivity analysis that we carry out. The degree of self-financing of consumption tax cuts in real terms is 11.5 percent in our benchmark and in the 8.6-15.6 range in our sensitivity analysis. Since the magnitudes that we derive for self-financing are at the bottom of the range calculated in previous literature, we conclude that in our framework tax cuts not only do not deliver a "free lunch", but that the lunch is also not that "cheap".

In addition to the budgetary impact, the tax reforms that we study also have important implications for domestic and foreign macroeconomic variables. A reduction in the domestic labor income tax rate generates a domestic boom, in which both output and consumption increase. The foreign economy is affected both in the short and in the long run through various transmission channels (an expenditure switching effect, a terms of trade effect, and a trade surplus/deficit effect).

Another contribution of our paper is a comparison between alternative (income-tax based versus consumption-tax based) fiscal stimulus packages. We wiev this as an important issue, since the policy makers of several industrial countries have shown, in recent years, a renewed interest in fiscal policy as a counter-cyclical tool. For example, tax cuts have been used to

[5] Following the seminal paper by Obstfeld and Rogoff (1995, 1996), important contributions to this literature include, but are not limited to, Betts and Devereux (2000, 2001), Corsetti and Pesenti (2001), and Obstfeld and Rogoff (2000, 2002). Surveys of this literature are provided by Lane (2001), Sarno (2001), Coutinho (2005), and Corsetti (2007).

stimulate the economy in the US more than once in the last decade, while Japan also tried to boost growth in the 1990s through an expansionary fiscal policy. In Europe, the Stability and Growth Pact has been recently re-interpreted in a way that facilitates the countercyclical use of fiscal policy. The importance of fiscal policy as a tool to stimulate the economy in a downturn was also recently stressed by the IMF's Managing Director, who stated *"But in a sense, medium-tem fiscal policy is all about saving for a rainy day. It is now raining"* (Strauss-Kahn 2008). Our results show that, if a given reduction in public spending and total revenue collection is achieved by a consumption (rather than income) tax rate reduction, the impact on domestic output is larger in the very short run but smaller in the medium and long run.

The importance of the issues on which we focus has obviously not escaped previous contributions. Most of the papers in the tax reform literature use closed-economy endogenous growth or neoclassical models to ascertain the existence of dynamic Laffer effects. Ireland (1994) finds that in an endogenous growth model an income tax reduction from an original rate of 20 percent generates a dynamic Laffer effect as long as the new rate is greater than 7.6 percent. Pecorino (1995) criticizes Ireland (1994) for not taking into account that returns from human capital accumulation are less highly taxed compared to other income sources, and shows that if this is taken into account dynamic Laffer effects only emerge for initial levels of tax rates of the order of 60 percent. Novales and Ruiz (2002) extend Ireland (1994) and Pecorino (1995) by explicitly taking into account transitional dynamics between balanced growth paths. They show that dynamic Laffer effects can arise for reductions of income tax rates of up to 5 percentage points starting from an initial rate of 23 percent. Bruce and Turnovsky (1999) stress that Ireland's result rely on an implausibly high (greater than unity) intertemporal elasticity of substitution and that dynamic Laffer effects can be ruled out under more realistic parameterizations.

Dynamic Laffer effects are likely to emerge in literature discussed above because, under the assumption of endogenous growth, the growth impact of tax cuts are large. This is not necessarily the case in neoclassical Real Business Cycle (RBC) models, in which the issue is rather how much of the tax cut pays for itself. Accordingly, Mankiw and Weinzierl (2006) have recently shifted the research focus, in a neoclassical setting, from dynamic Laffer effects to the degree of self-financing, in the sense of how much of the "partial equilibrium" revenue loss is paid for by growth (see section IV.A below for the formal definition). Using this methodology, they calibrate a neoclassical growth model to the US, finding that 17 percent of a labor income tax cut is self-financing for standard parameter values, a magnitude close to the one (19 percent) calculated by Trabandt and Uhlig (2006) in a similar exercise.

Compared to the above mentioned closed-economy papers, one innovation of our contribution is that of jointly analyzying the macroeconomic and budgetary implications of tax reforms in an open economy framework. This allows us, in the spirit of Frankel and Razin (1989), to study the domestic and international impact of unilateral tax reforms in a

globalized economy. A paper which takes a similar open economy view of tax reforms is Mendoza and Tesar (1998). Using a dynamic neoclassical two-country model, they study the domestic and international implications of a US tax reform. One difference of our contribution compared to theirs is that they do not explicitly focus on dynamic Laffer effects and on the degree of self-financing, since the tax reforms they analyze are such that any revenue loss caused by reductions in income tax rates is perfectly offset by an increase in consumption taxes.[6] Our choice of using a New Keynesian model is another important difference compared to all the paper reviewed above, which allows us to take into account how tax reforms interact with market imperfections such as the degree of nominal rigidity in the economy.

The paper is organized as follows. Sections II and III respectively introduce the model and our benchmark parameterization. Section IV and V present and compare the results of income tax and consumption tax rates reductions. Section VI focuses on a revenue-neutral tax reform. Section VII presents some sensitivity analysis. Section VIII concludes.

II. THE MODEL

We use a standard NOEM model, similar to the one developed by Betts and Devereux (2000). Compared to the latter, there are two main differences. The first is the introduction of income and consumption taxes instead of lump-sum ones. The second is that nominal rigidities take the form of staggered price setting as in Calvo (1983), rather than one-period fixed prices. Betts and Devereux (2000) assume that a fraction of firms fix prices in the currency of the consumer. Their model therefore allows for both Local Currency Pricing (LCP)—which implies deviations from Purchasing Power Parity (PPP)—and Producer Currency Pricing (PCP). In this paper we focus our attention on the PCP case, abstracting from deviations from PPP. The model contains two countries. Firms and households are indexed by $z \in [0,1]$. A fraction n of households and firms are located in the domestic country, while $1-n$ are located in the foreign country. In the presentation of the model below we will introduce domestic equations. Unless equations for the foreign country are explicitly discussed, they can be assumed to be symmetric to the equations for the domestic country.

A. Households

Households gain utility from private consumption and real balances, and experience disutility from supplying labor. Their utility function is therefore given by

[6] Although we mostly focus on policy experiments in which governments adjust transfers to compensate changes in tax collection, in Section VI we also look at the implications of a revenue neutral exercise similar in spirit to the one carried out by Mendoza and Tesar (1998).

$$U_t = \sum_{s=t}^{\infty} \beta^{s-t} [\log C_s + \frac{\chi}{1-\varepsilon} (\frac{M_s}{P_s})^{1-\varepsilon} - \frac{l_s(z)^{\nu+1}}{\nu+1}] \quad (1)$$

where $0 < \beta < 1$ is the discount factor, C_s is a composite good representing private consumption and P_s is the price index associated with it. M_s denotes nominal money balances and $l_s(z)$ the household's supply of labor; $\varepsilon > 0$ is the inverse of the consumption elasticity of money demand, ν is the elasticity of the marginal disutility of producing output with respect to output, and χ is a positive parameter.

The composite private consumption good is defined in the following equation as an aggregate across the individual goods produced by firms

$$C_t = [\int_0^1 c_t(z)^{\frac{\theta-1}{\theta}} dz]^{\frac{\theta}{\theta-1}} \quad (2)$$

where θ is the elasticity of substitution between any pair of individual goods. The associated price index is

$$P_t = [\int_0^n p_t(z)^{1-\theta} dz + \int_n^1 (E_t p_t^*(z))^{1-\theta} dz]^{\frac{1}{1-\theta}} \quad (3)$$

where $p_t(z)$ is the price of good z expressed in domestic currency, $p_t^*(z)$ is the foreign currency price of foreign good z and E is the nominal exchange rate, defined as the price of the foreign currency in terms of the domestic currency.

The budget constraint of the domestic representative household is given by

$$M_t + \delta_t D_t = D_{t-1} + M_{t-1} + (1-\tau_t^I) w_t l_t(z) - (1+\tau_t^C) P_t C_t + \pi_t + P_t T_t \quad (4)$$

where D denotes the household's holding of nominal bonds. Bonds are denominated in the currency of the domestic country and account for international shifts in wealth, δ is the price of a bond (the inverse of one plus the nominal interest rate), w_t is the nominal wage paid to the household in a competitive labor market, π is the household's share of profits received from firms, τ_t^I and τ_t^C are the tax rates on household income and consumption, and T_t denotes real transfers from the government.[7] Given that bonds are denominated in domestic currency, the budget constraint of the foreign representative household is

[7] The fact that bonds are denominated in domestic currency does not introduce any asymmetry across countries, since we assume open capital markets so that nominal interest rates are equalized internationally. Furthermore, PPP holds under PCP.

$$M_t^* + \delta_t \frac{D_t^*}{E_t} = \frac{D_{t-1}^*}{E_t} + M_{t-1}^* + (1-\tau_t^{I^*}) w_t^* l_t^*(z) - (1+\tau_t^{C^*}) P_t^* C_t^* + \pi_t^* + P_t^* T_t^* \quad (5)$$

where foreign variables are denoted by asterisks. A global asset-market clearing condition $nD_t + (1-n)D_t^* = 0$ also holds.

Domestic households maximize (1) subject to (4), and an analogous optimization problem holds for foreign households. The resulting first order conditions are

$$\delta_t (1+\tau_t^C) P_{t+1} C_{t+1} = \beta (1+\tau_{t+1}^C) P_t C_t \quad (6)$$

$$\delta_t (1+\tau_t^{C^*}) P_{t+1}^* C_{t+1}^* E_{t+1} = \beta (1+\tau_{t+1}^{C^*}) P_t^* C_t^* E_t \quad (7)$$

$$l_t^{\nu} = \frac{(1-\tau_t^I)}{(1+\tau_t^C)} \frac{w_t}{C_t P_t} \quad (8)$$

$$l_t^{*\nu} = \frac{(1-\tau_t^{I^*})}{(1+\tau_t^C)} \frac{w_t^*}{C_t^* P_t^*} \quad (9)$$

$$\frac{M_t}{P_t} = \left(\frac{\chi (1+\tau_t^C) C_t}{1-\delta_t}\right)^{\frac{1}{\varepsilon}} \quad (10)$$

$$\frac{M_t^*}{P_t^*} = \left(\frac{\chi (1+\tau_t^{C^*}) C_t^*}{1-\frac{\delta_t E_{t+1}}{E_t}}\right)^{\frac{1}{\varepsilon}} \quad (11)$$

Equations (6) and (7) are the Euler equations for optimal domestic and foreign consumption including taxes, they reduce to standard Euler equations if the tax rate on consumption is kept constant. Equations (8) and (9) are the domestic and foreign optimal labor supply equations, which equate the disutility of supplying an extra unit of labor with the marginal utility of the extra private consumption that can be bought due to the marginal increase in labor supply. Equations (8) and (9) show that higher labor or consumption taxes reduce labor supply for given levels of the real wage and consumption. Finally, equations (10) and (11) show that households' optimal money demand is an increasing function of private consumption (including taxes) and a decreasing function of the interest rate.

B. The Government

We assume that all government spending is for public transfers to households, which can be financed through income and consumption taxes or seignorage.[8] We therefore abstract from government spending for public consumption and investment. Taking into account symmetry across agents, the government budget constraint in per-capita terms can therefore be written as

[8] In what follows we will keep money supply constant, therefore abstracting from seignorage in practice.

$$T_t = \tau_t^l \frac{w_t}{P_t} l_t + \tau_t^C C_t + \frac{M_t - M_{t-1}}{P_t} \quad (12)$$

where T_t denotes real transfers.

C. Firms

Technology

Each firm produces a differentiated good according to the simple production function

$$y_t(z) = l_t(z) \quad (13)$$

where $y_t(z)$ is the output of firm z and $l_t(z)$ the labor input used by firm z.

Profits

We assume that each firm enjoys a certain degree of monopolistic power in the production of its differentiated good. Under this assumption, demand for the output of firm z is given by

$$y_t^d(z) = (\frac{p_t(z)}{P_t})^{-\theta} C_t^W \quad (14)$$

where C_t^W is world aggregate consumption given by $C_t^W = nC_t + (1-n)C_t^*$ (15)

Profits are defined as $\pi_t(z) = p_t(z) y_t(z) - w_t l_t$. Using (13), (14) and (15) profits can be written as

$$\pi_t(z) = (p_t(z) - w_t)(\frac{p_t(z)}{P_t})^{-\theta} (nC_t + (1-n)C_t^*) \quad (16)$$

Price Setting

In the absence of price rigidities, the profit maximization process would imply that the price of each differentiated good is given by a simple mark-up over wages, according to the formula

$$p_t(z) = \frac{\theta}{\theta - 1} w_t \quad (17)$$

However, following Calvo (1983), we introduce nominal rigidities by assuming that each firm resets its price with a probability $1-\gamma$ in each period, independently of other firms and independently of the time elapsed since the last adjustment. Each firm has to take into account, when setting its profit-maximizing price, that in every subsequent period there is a probability $0 < \gamma < 1$ that it will not be able to revise its price setting decision. When setting a new price in period t, each firm seeks to maximize the present value of profits weighting

future profits by the probability that the price will still be effective in that period. Thus the representative home firm seeks to maximize

$$\max_{p_t(z)} V_t(z) = \sum_{s=t}^{\infty} \gamma^{s-t} \zeta_{t,s} \pi_s(z) \tag{18}$$

where $\zeta_{t,s}$ is the domestic discount factor between period t and period s, defined as

$\zeta_{t,s} = \Pi_{j=s}^{t} (1+i_j)^{-1}$, where i the domestic nominal interest rate. The result is the following pricing rule

$$p_t(z) = \left(\frac{\theta}{\theta-1}\right) \frac{\sum_{s=t}^{\infty} \gamma^{s-t} \zeta_{t,s} (C_s^W)\left(\frac{1}{P_s}\right)^{-\theta} w_t}{\sum_{s=t}^{\infty} \gamma^{s-t} \zeta_{t,s} (C_s^W)\left(\frac{1}{P_s}\right)^{-\theta}} \tag{19}$$

All firms in a country are symmetric and every firm that changes its price in any given period chooses the same price and output consistently with (19). The structure of price setting implies that each period a fraction of $1-\gamma$ of firms sets a new price and the remaining fraction keeps their price unchanged.

D. The Initial Steady State

In the policy exercises which we carry out below, we log-linearize the model around a symmetric steady state. We consider the special case in which initial net foreign assets are zero ($D_0 = 0$). Under this assumption we have, using the zero subscript to denote the initial steady state

$$y_0 = C_0 = \left[\left(\frac{1-\tau_0^I}{1+\tau_0^C}\right)\left(\frac{\theta-1}{\theta}\right)\right]^{\frac{1}{\nu+1}} \tag{20}$$

III. PARAMETERIZATION

The benchmark parameterization of the model mostly follows Betts and Devereux (2000). The elasticity of substitution between differentiated goods θ is set to 11. The discount factor β is assumed equal to 0.94, implying a steady-state interest rate of about 6 percent. The consumption elasticity of money demand 1/ε is set to 1. The disutility parameter ν is assumed to be unitary. The countries are assumed to be of equal size, implying n=0.5. The price rigidity parameter is set at γ=0.5. Initial income and consumption tax rates of respectively 20 and 8 percent are assumed $(\tau_0^I = 0.2; \tau_0^C = 0.08)$. Our goal is to present simple numerical examples in order to illustrate the theoretical mechanisms underpinning the domestic and international impact of tax reforms. We therefore do not calibrate the model to any particular

country. In any case, we believe our initial income tax rates to be within the ballpark of the range of plausible estimates for many industrial and emerging market economies.

Baxter and King (1993) and Ireland (1994), for example, use $\tau_0^I = 0.2$ as a benchmark in parameterizations of the US economy, while Mankiw and Weinzierl (2006) use $\tau_0^I = 0.25$. Mendoza, Razin, and Tesar (1994) estimate effective labor income tax rates in the 26-28 percent range for the US, the UK, Canada and Japan in 1988 (the last year for which they do this exercise). Their estimates are much higher for the other industrial countries included in their sample (reaching 47 percent for France). However, considering that in many emerging markets (such as those which have recently moved towards the flat tax) income tax rates are much lower, we believe that $\tau_0^I = 0.20$ percent is an appropriate parameterization for our exercises, which aim at starting from a somewhat standard fiscal stance. Similar considerations were made in the choice of $\tau_0^C = 0.08$.[9] In sections IV, V and VI we report and discuss the results of calibrations under this benchmark parameterization derived using the algorithm developed by Klein (2000) and McCallum (2001). In Section VI we present some sensitivity analysis experiments in which we look at the implications of a wider range of variation for the labor disutility and nominal rigidity parameters.

IV. The Domestic and International Effects of a Cut in the Income Tax Rate

In this section we analyse the implications of an unexpected reduction in the income tax rate τ_t^I from 0.2 (a 20 percent income tax rate) to 0.19 (a 19 percent income tax rate), which corresponds to a 5 percent cut in the rate. Since we want to initially focus on the macroeconomic and budgetary implications of income tax reform abstracting from changes in other taxes, we leave the consumption tax rate τ_t^C unchanged at its initial steady state level of 0.08 (an 8 percent consumption tax rate) in this section.[10]

The results of this policy exercise are presented in Figure 1. The vertical axes show percentage deviations from the initial steady state. For variables whose initial steady-state value is zero, deviations are expressed in relation to initial output. Figure 1 shows the response of domestic and foreign macroeconomic variables (including total revenue collection). Although much of the public opinion debate on the budgetary implications of tax reforms is cast in terms of the impact on nominal revenue collection, what ultimately matters for the government ability to carry out its functions is the amount of real resources available to the public sector. Since, unlike most of the papers which have looked at similar issues, we use a monetary model with nominal rigidity, we can analyze the response of both nominal revenue collection (NRC) and real revenue collection (RRC). Those are reported in Figure 1(e.g.) and can be derived from (5) as follows (using hats to denote log-deviations):

[9] The estimate of effective tax rates on consumption made by Mendoza, Razin, and Tesar (1994) vary from about 5 percent for the US and Japan to about 21 percent for France.

[10] In section V we consider the case of changes in the consumption tax rate.

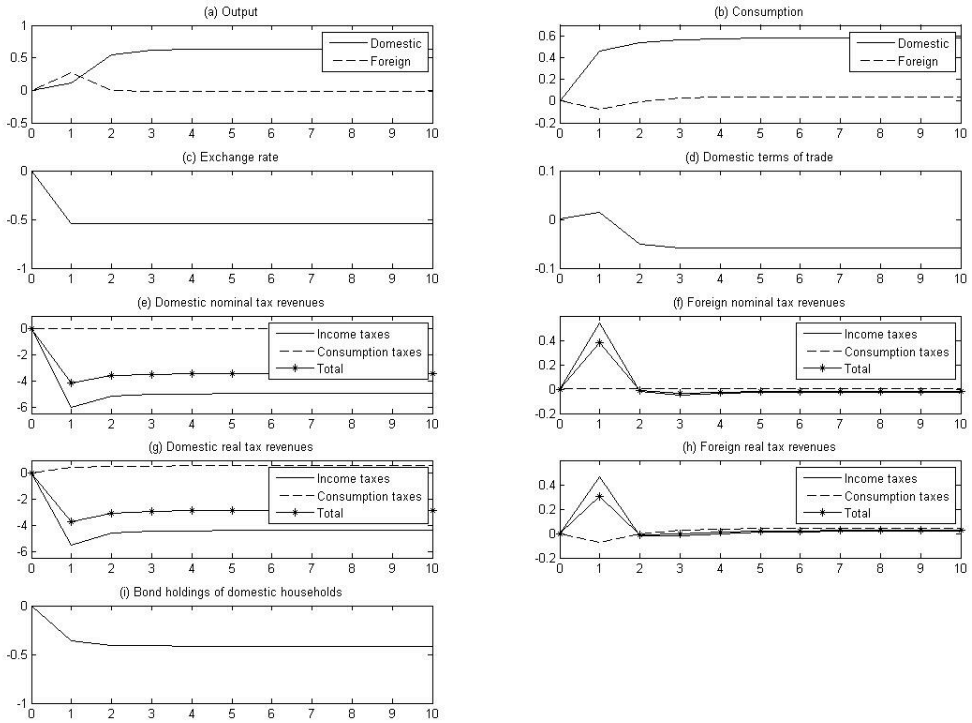
$$\hat{NRC} = u(\hat{\tau}_t^I + \hat{w}_t + \hat{l}_t) + (1-u)(\hat{\tau}^C + \hat{C}_t + \hat{P}_t) \tag{21}$$

$$\hat{RRC} = u(\hat{\tau}_t^I + \hat{w}_t + \hat{l}_t - \hat{P}_t) + (1-u)(\hat{\tau}^C + \hat{C}_t) \tag{22}$$

where u denotes the share of income tax on total taxes in the initial steady state (in our benchmark parameterization this share is equal to 0.7, see Appendix for the derivation). Equations (21) and (22) refer to *total* revenue collection. In equation (21), $u(\hat{\tau}_t^I + \hat{w}_t + \hat{l}_t)$ denotes nominal income tax collection, while $u(\hat{\tau}^C + \hat{C}_t + \hat{P}_t)$ denotes nominal consumption tax collection. Real income and consumption tax collection are derived in an analogous way in equation (22).

Figure 1(d) also includes the response of the domestic terms of trade, defined as the Calvo-weighted relative price of domestic exports in terms of domestic imports. Thus the increase in Figure 1(d) implies an improvement of the domestic terms of trade in the short run.

Figure 1. The Effects of a Domestic Income Tax Reduction



A. The Impact on the Domestic Economy

Reducing the income tax rate increases the opportunity cost of leisure. Domestic households therefore substitute out of leisure and into consumption. The impact of this substitution effect is shown in Figure 1(a) and 1(b): both domestic output and consumption increase. These results are consistent with the analysis of real business cycle models. Baxter and King (1993), for example, look at the impact of an exercise symmetric to ours, finding symmetric results: a balanced-budget increase in public spending financed by income taxes reduces both output and consumption in their model.

As Figure 1(g) shows, domestic real revenue collection permanently falls by about 3 percent compared to its initial steady-state level as a consequence of the policy that we are analyzing. Figures 1(e) and 1(g) show that, although a lower income tax rate increases labor supply, the impact of this on income and total revenue collection is not big enough to compensate for the rate reduction. For the reasons discussed above, real consumption increases following the income tax reduction. This implies that consumption tax revenue collection increases in real terms even at an unchanged consumption tax rate. However, the quantitative impact of the increase in consumption tax collection is small (Figure 1(g)). The change in total real tax collection can be explained with reference to equation (22). Since the consumption tax rate does not change in this policy exercise $(\hat{\tau}^C = 0)$, the change in real consumption tax collection is given by $(1-u)\hat{C}_t$. The low initial share of consumption taxes in our benchmark parameterization $((1-u) = 0.3))$ explains why the impact of an increase in real consumption tax collection is not big enough to prevent a strong decrease in overall real tax collection.

In terms of nominal tax collection, there is no consumption tax impact under our parameterization. Since we have fixed the consumption elasticity of money demand to unity, and we keep nominal money supply fixed, equation (10) implies that changes in nominal consumption and prices are mirror images of each other. Nominal collection of consumption tax therefore does not change. In terms of equation (21) $\hat{\tau}^C = 0$, and $\hat{C}_t$ and $\hat{P}_t$ offset each other.

Table 1. Income tax rate cut: tax revenues collection changes 1/

Change in nominal tax revenues				Change in real tax revenues			
t = 1	t = 3	t = 5	New steady state	t = 1	t = 3	t = 5	New steady state
-4.2	-3.5	-3.5	-3.5	-3.7	-2.9	-2.9	-2.9

1/ Percentage changes with respect to the initial steady state.

Table 1 summarizes the impact on tax collection of a change in the income tax rate at various time horizons. As it is clear from Figure 1 and Table 1, in our model the minimum necessary condition for dynamic Laffer effects—that following a reduction in tax rates today taxes will be higher at some point in the future in the absence of further policy changes—is not satisfied. Since no dynamic Laffer effects arise in our model, it is clear that tax cuts do not

result in a "free lunch" in our analysis. This is in stark contrast with the results of some of the closed-economy, endogenous growth models reviewed in the introduction (such as Ireland (1994) and Novales and Ruis (2002)) in which significant dynamic Laffer effects emerge for parameterizations of the initial tax rates similar to ours. As we have already stressed in the introduction, this is not surprising in the endogenous growth literature, in which the growth effects of tax cuts are likely to be strong.

A more relevant comparison of our results is with RBC models in which the rate of growth is exogenous. Trabandt and Uhlig (2006) look at the impact of reductions in income taxes financed by cuts in government spending transfers for a parameterizaiton similar to ours. Their results are quantitatively similar to ours, since in the new steady state revenue collection falls by about 2 percent, compared to about 3 percent in our case.[11] How can quite different models generate such close results? One explanation is that that while the introduction of market imperfections—compared to the RBC framework—entails that our initial steady-state is suboptimal and larger efficiency gains can be derived from reducing the tax burden, those gains are offset by the open-economy dimension, which implies that part of the growth benefits of the domestic tax reduction accrue to the foreign country. The importance of the open economy dimension in preventing the emergence of dynamic Laffer effects in our framework is even more evident if our results are compared with the RBC model and Leeper and Yang (2008), in which a 1 percent reduction in income taxes—starting from an initial tax rate of 25 percent—implies a revenue loss much smaller than ours (about 0.3 percent compared to 3 percent in our case). The possibility of analysing the interaction of market imperfections and open economy channels is an advantage of using a NOEM framework, on which we will focus more explicitly in section IV B.

The Degree of Self Financing: if not a "Free" Lunch, at Least a "Cheap" Lunch?

As we have discussed above, "free lunches" deriving from tax cuts are generally ruled out both in our NOEM model and in previous RBC models. Recent research (Mankiw and Weinzierl 2006; Trabandt and Uhlig 2006) however, has shifted the focus in the RBC literature from "free lunches" to "cheap lunches", in the sense of investigating whether tax cuts which do not generate dynamic Laffer effects can be at least largely self-financing.

The degree of self financing has been defined as[12]

$$100*(1-x) \qquad (24)$$

where

[11] See Trabandt and Uhlig (2006), Table 7. The fall in revenue collection is smaller if the initial tax rate is higher (see Trabandt and Uhlig (2006), Table 8).

[12] See Mankiw and Weinzierl (2006) and Trabandt and Uhlig (2006).

$$x = \frac{dR / d\tau(gen)}{dR / d\tau(par)} \tag{25}$$

where the numerator of (25) is the response of total revenue collection to tax rate changes in a general equilibrium sense (in which all endogenous variables react to the rate change) while the denominator is the response of total revenue collection to tax rate changes in a partial equilibrium sense (in which the response of endogenous variables is shut off). The intuition behind this definition is that if x=1 then the general equilibrium effect of tax changes on revenue collection is equal to the partial equilibrium effect. In this case there is no self-financing (the degree of self-financing is zero) and the partial equilibrium methodology used by the JCT to evaluate the impact of proposed tax legislation is appropriate. In most cases, however, the degree of self-financing is likely to be positive.

Mankiw and Weinzierl (2006), for example, calculate it to be 50 percent for capital income taxes and 17 percent for labor income taxes for the US. While Trabandt and Uhlig (2006) find values of 47 percent (capital income) and 19 percent (labor income) for the US and 85 percent (capital income) and 54 percent (labor income) for EU-15. Leeper and Yang (2008) mostly focus on revenue-neutral exercises in which equation (25) is not applicable. They do look, however, at a case in which income tax cuts are financed by lower transfers, finding a degree of self-financing of 47 percent.

Since we have introduced money and nominal rigidities in our model, we can calculate the degrees of self-financing in terms of both nominal and real revenues. Using (21) and (22), we can easily calculate the ratio defined in (25) for our model. This ratio is given at any time horizon by

$$\frac{u(\hat{\tau}_t^I + \hat{w}_t + \hat{l}_t) + (1-u)(\hat{\tau}^C + \hat{C}_t + \hat{P}_t)}{u\hat{\tau}_t^I + (1-u)(\hat{\tau}_t^C)} \tag{26}$$

for the case of nominal revenue collection and by

$$\frac{u(\hat{\tau}_t^I + \hat{w}_t + \hat{l}_t - \hat{P}_t) + (1-u)(\hat{\tau}^C + \hat{C}_t)}{u\hat{\tau}_t^I + (1-u)(\hat{\tau}_t^C)} \tag{27}$$

for the case of real revenue collection. The numerators of equations (26) and (27) are the general equilibrium responses of tax collection to tax rates changes, while the denominators are the partial equilibrium responses in which endogenous variables do not react to tax changes ($\hat{w}_t = \hat{l}_t = \hat{C}_t = \hat{P}_t = 0$).

Table 2. Income Tax Rate Cut: Degree of Self Financing 1/

Nominal tax revenues				Real tax revenues			
t = 1	t = 3	t = 5	New steady state	T = 1	t = 3	t = 5	New steady state
-20.4	-0.4	0.4	0.5	-7.0	15.9	17.1	17.3

1/ See equations (25) and (26) for the definition.

Table 2 reports the degree of self-financing at various horizons following an income tax cut. One result emerging from Table 2 is that in our model it matters whether we consider the degree of self-financing in terms of nominal or real tax revenues, since the results are significantly different. More importantly, Table 2 shows that the degree of self-financing in real terms stabilizes at about 17 percent in the new steady state.[13] This value is of the same order of magnitude of those calculated by Mankiw and Weinzierl (2006) and Trabandt and Uhlig (2006) for a labor income tax cut in the US. As discussed above, however, the same authors have shown that the degree of self-financing can be significantly larger in the case of capital income tax cuts or when the parameterization is based on higher initial tax rates (such as those used by Trabandt and Uhlig (2006) in their parameterization of the EU-15). Furthermore, Leeper and Yang (2008) find a much larger degree of self-financing. Given that in our exercise the degree of self-financing is at the bottom of the range derived in the existing literature, we can conclude that in our model not only a cut in the income tax rate does not produce a "free lunch", but also that the "lunch" is not that "cheap". We are now ready to move to the analysis of global implications of tax reforms.

B. The International Effects

As we have already stressed above, one advantage of using the NOEM framework is the possibility to analyze how market imperfections interact with the open economy dimension in determining the results. One important open-economy channel obviously works through exchange rate movements. Figure 1 (c) shows that the reduction in domestic income taxes implies an appreciation of the domestic nominal exchange rate (a fall in the price of foreign currency in terms of domestic currency). This appreciation is due to a "money demand" effect stemming from the increase in domestic consumption caused by the domestic tax cut. Since money demand is a positive function of consumption including taxes (see equations (10) and (11)), the increase in domestic consumption (both in absolute terms and relative to foreign consumption) increases domestic money demand compared to foreign. This implies that the domestic currency appreciation displayed in Figure 1(c) is required to reestablish equilibrium in the money market.

[13] The result of a negative degree of self-financing at t=1 is due to the dynamics of the nominal wage, which in the short run undershoots its new long-run steady-state level, thus implying that the "general equilibrium" revenue loss is temporarily higher than the "partial equilibrium" one in equations (26) and (27).

Figure 1(a) also shows a temporary increase of foreign output following the domestic tax cut. This is partly due to the increase in world demand deriving from higher domestic consumption. Since household preferences do not display home bias the increase in domestic consumption falls on foreign as well as on domestic goods (an "expenditure boosting" effect). Figure 1(a) also shows that the short run increase in foreign output is faster than the one in domestic output. This suggests that, in addition to the global expenditure boosting effect discussed above, an "expenditure switching" effect is also at work: part of the increase in foreign output is due to the fact that foreign goods become cheaper as a consequence of the appreciation of the domestic currency. The expenditure switching effect of a nominal exchange rate change alters the relative price of goods only as long as prices are sticky. Since under our parameterization half of the firms adjust their prices in every period, the expenditure switching effect peters out fast. This explains why the increase in foreign output is temporary.

Even though the impact of the expenditure switching effect is temporary, the fact that part of the benefits—in terms of output stimulation—of the domestic tax reduction accrue to foreigners explains why dynamic Laffer effects do not emerge in our model and the degree of self-financing is lower than the ones calculated in RBC models for similar parameterizations.

The short-run increase in foreign output is matched by a short-run reduction in foreign consumption. In the long run, foreign consumption slightly increases compared to its initial steady-state level. This dynamics of foreign consumption is driven by changes in the terms of trade and by foreign households' desire to use their temporary income gains to smooth consumption over time. Since in the short run, due to the appreciation of the domestic currency, the foreign terms of trade worsen (an increase in Figure 1(d)), foreign households reduce their short-run consumption. In this way they save part of their extra short-run income (Figure 1(a)), thus running a current account surplus (Figure 1(i)). In the medium and long run, however, the foreign terms of trade improve (a fall in Figure 1(d)) due to a relative increase in the supply of domestic goods which implies a fall in the relative price of domestic goods. This terms of trade effect, together with external wealth accumulation due to the current account surplus, allow foreign households to increase their long-run consumption even though their long-run income returns to almost initial steady-state levels. Figure 1(h) also shows that the domestic tax reform has a temporary positive impact on foreign tax collection, due to the fact that foreign households increase their labor supply at an unchanged income tax rate level.

The responses of macroeconomic variables to tax cuts presented in this section are broadly consistent with findings of the empirical literature. The result that domestic activity is stimulated in response to a tax reduction is a standard one in studies of the US economy (see for example Blanchard and Perotti (2002)). Although empirical studies of the international transmission of fiscal policy are scarce, our result of a positive international output spillover is consistent with foreign output multipliers calculated by Giuliodori, Beetsma, and Klassen (2006) for several European countries.

V. CONSUMPTION TAX CUTS

In this section we look at a policy alternative to the one considered in the previous section, that is one in which the government decides to unexpectedly reduce the consumption tax rate rather than the labor income tax rate. In the policy experiment that we present here τ_t^I is therefore kept constant at its initial steady-state level 0.2 (a 20 percent income tax rate) while the consumption tax rate τ_t^C is reduced from 0.08 to 0.07 (from 8 to 7 percent, which amounts to a 12½ percent decrease in the rate). In addition to allowing us to investigate the issue of whether a consumption tax cut can deliver a "free" or a "cheap" lunch, the exercise presented in this section also makes possible a comparison with the one discussed in section IV, thus highlighting the different impact on domestic output and consumption, as well as on the foreign country, of alternative fiscal stimulus packages. The results of this exercise are summarized in Figure 2 and in Tables 4 and 5.

Figure 2. The Effects of a Domestic Consumption Tax Reduction

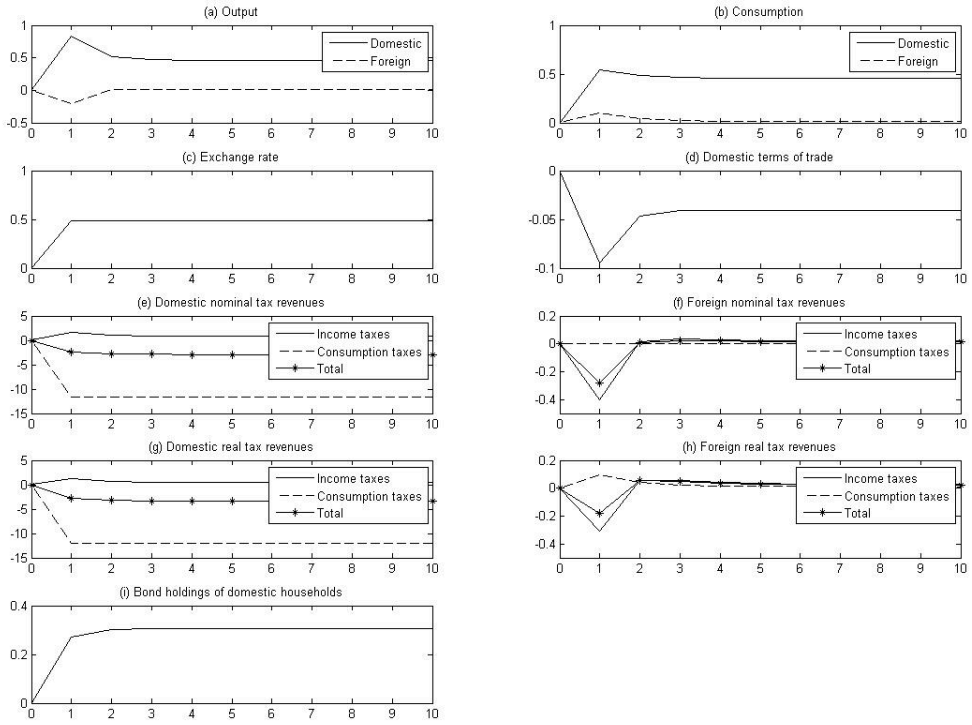


Table 4. Consumption Tax Rate Cut: Domestic Tax Revenues Collection Changes 1/

Change in nominal tax revenues				Change in real tax revenues			
t = 1	t = 3	t = 5	New steady state	t = 1	t = 3	t = 5	New steady state
-2.4	-2.9	-2.9	-2.9	-2.8	-3.3	-3.4	-3.4

1/ Percentage changes with respect to the initial steady state.

Table 5. Consumption Tax Rate Cut: Degree of Self Financing 1/

Nominal tax revenues				Real tax revenues			
t = 1	t = 3	t = 5	Steady state	t = 1	t = 3	t = 5	Steady state
37.9	24.5	24.0	23.9	27.8	12.4	11.6	11.5

1/ See equations (25) and (26) for the definition.

One important difference between income and consumption tax reductions is that they have opposite effects on the nominal exchange rate. While in the case of an income tax cut the domestic exchange rate appreciates (Figure1(c)), a consumption tax cut results in a domestic depreciation (Figure 2(c)). The intuition for this result is the money demand effect already discussed in section IV. Since money demand is a positive function of consumption including taxes, the reduction in the consumption tax rate has a negative effect on domestic money demand, which for our parameterization is stronger than the effect of the increase in real consumption excluding taxes. The negative impact on money demand implies a transmission mechanism symmetric to the one described in section IV, resulting here in a domestic depreciation (rather than in an appreciation as in section IV).

A result that can be clearly seen in Figure 2 and Table 4 is that, even in the case of consumption tax cuts, no dynamic Laffer effects emerge in our model. Domestic labor income tax collection increases in this case, because domestic households increase their labor supply at an unchanged income tax rate. The increase in labor income tax collection, however, is not large enough to compensate for the reduction in consumption tax collection. As a result, total revenue collection in real terms drops by 3.4 percent in the steady-state, an order of magnitude comparable to the one derived in the case of income tax reductions (compare Tables 1 and 4). Furthermore, the degree of self-financing in real terms in the new steady state is 11.5 percent (Table 5), which is lower than the 17.3 percent derived for the case of income tax reductions (Table 2). Table 5 also shows that the degree of self-financing is larger in the short-run (27.8 percent) than in the long-run. This result is due to the fact that the expenditure switching effect, which shifts demand towards domestic goods thus increasing domestic income tax collection due to higher labor, is stronger in the short run.

In summary, consumption tax cuts do not generate a “free lunch” for the budget. In fact, the “lunch” they deliver is, in our model, less “cheap” than the one delivered by labor income tax cuts. While previous literature did not delve into the study of the self-financing features of consumption tax cuts, our results are broadly consistent with the findings of the endogenous growth model of Novales and Ruiz (2002), in which no dynamic Laffer effects emerge for consumption tax reductions, as well as with those of Trabandt and Uhlig (2006), who find mixed results (depending on the specific utility functional form) on the existence of steady-state Laffer curves for consumption taxes.

One advantage of introducing both income and consumption taxes in the framework we use is that we can compare alternative options for fiscal stimulus packages. Comparing Figures 2(a) and 1(a) we can see that a fiscal expansion policy based on a one percentage point reduction in consumption taxes has a stronger and faster impact on short-run domestic output compared to a fiscal package based on a one percentage point reduction in income taxes. The

medium and long-term effects on domestic output of the two policies are, however, basically equivalent.

The fact that the domestic exchange rate depreciates instead of appreciating implies that the main spillover channels through which the domestic tax reduction affects the foreign country—the expenditure switching effect, the terms of trade dynamics, and the accumulation of external surplus/deficit—are now reversed compared to those presented in section IV. This result in a dynamics of foreign output and consumption following domestic consumption tax cuts which is almost a mirror image of the one stemming from domestic income tax cuts (compare Figure 1(a,b) with figure 2(a,b)). In particular, foreign output falls and foreign consumption increases in the short run when the domestic country chooses to stimulate the economy through a consumption-tax based fiscal package. The temporary reduction in foreign output implies that overall foreign revenue collection falls, because the drop in foreign income tax collection is not compensated by higher foreign consumption tax collection (Figure 2(f,h)). Since a domestic income-tax based fiscal package has a positive impact on short-term foreign revenues (Figure 1(f,h)), the negative short-run budgetary spillover derived here is another important difference between the two fiscal packages.

Alternative Options to Achieve a Given Reduction in Transfers

In Figure 2 and Tables 4 and 5 we have presented the results related to a 1 percentage point reduction in the consumption tax rate in order to compare such a fiscal stimulus package with the one (discussed in section IV) based on a 1 percentage point reduction in the income tax rate. A different exercise which can also give an interesting perspective on the comparison of income-tax based versus consumption-tax based fiscal stimulus packages is one in which the government reduces τ^C by the amount needed to stabilize steady-state public transfers at the same level implied by the income-based fiscal stimulus package studied in section IV. This comparison can give some insights on the implications of following different fiscal strategies for governments who have decided to reduce public spending by a given amount.

Since in our model the government budget is balanced in every period and, in the absence of seignorage, total tax collection is always equal to transfers, this exercise boils down to analysing the reduction in consumption tax rate which implies the same steady-state level of total revenue collection derived in section IV. The income tax rate reduction analysed in Section IV reduces total tax collection—and therefore transfers—by 2.9 percent in the new steady-state. The same reduction in transfers can be achieved with a 0.85 percentage points cut in the consumption tax rate. Figure 3 provides a comparison of these two different ways of achieving the same reduction in transfers.

Figure 3. Comparison of Alternative Tax Policy Options to Achieve a Given Reduction in Transfers

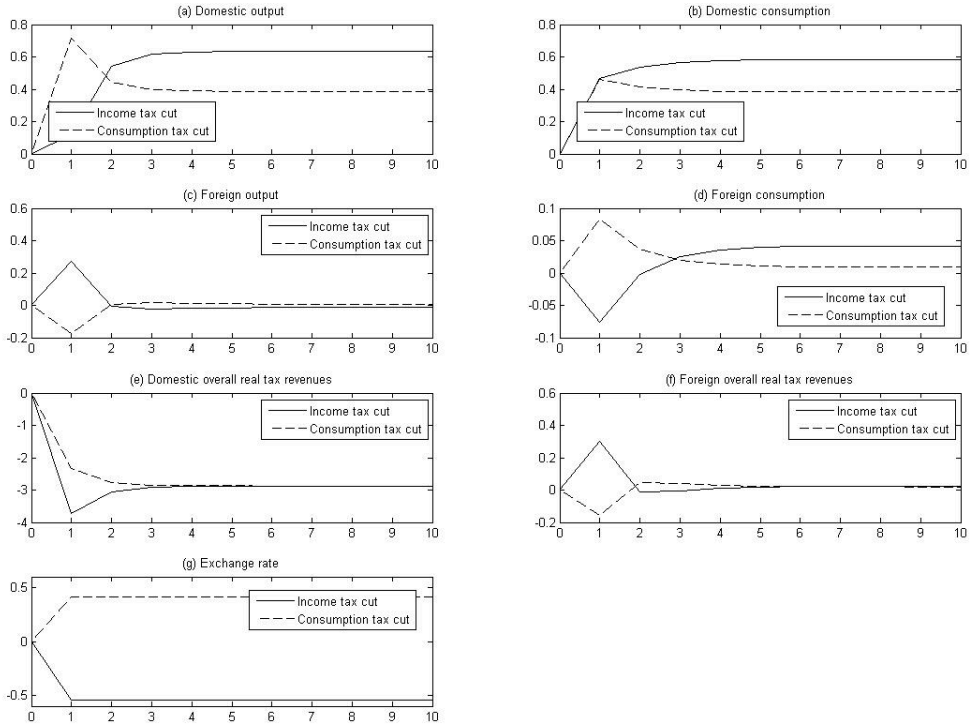


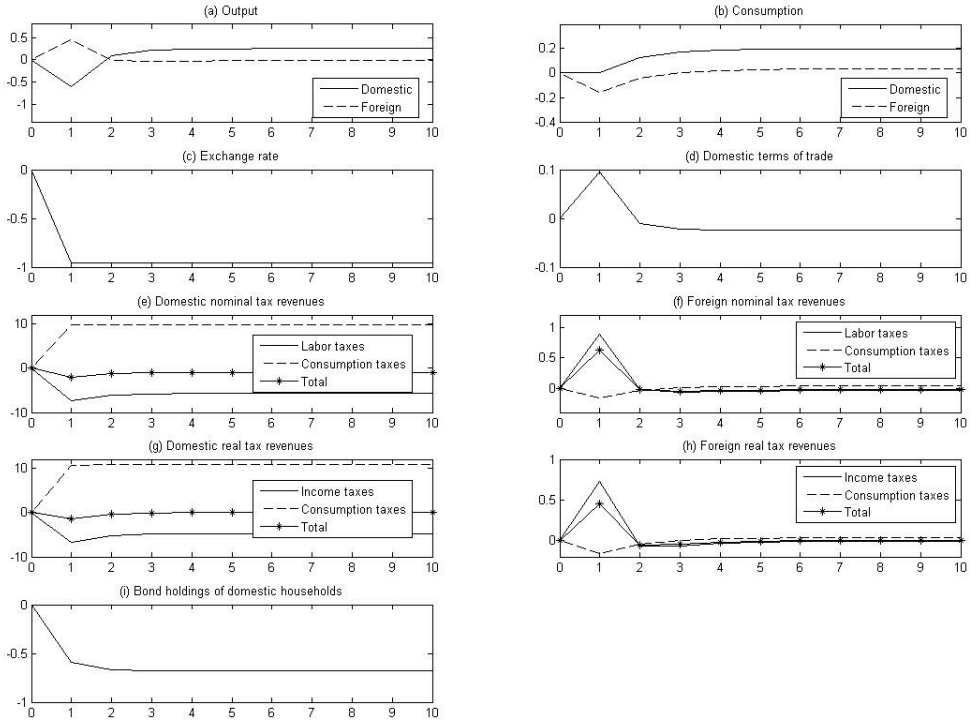
Figure 3(a) shows that, once the domestic government has decided to reduce transfers and total tax collection by a certain amount (in our example to 2.9 percent less than in the initial steady state) implementing this plan by reducing the consumption tax rate implies a larger short-run impact on domestic output compared to an income-tax based strategy. In the medium and long run, however, the income-tax based strategy stimulates the domestic economy more than the consumption-tax based one.

VI. A Revenue Neutral Tax Reform

In all the exercises considered so far, tax rates were exogenously reduced and revenue collection adjusted endogenously. In this section, we consider a policy in which the income tax rate is reduced as in section V and the consumption tax rate is increased by the amount needed to compensate the long-run revenue loss stemming from lower income taxes.

Following an income tax rate reduction from 20 to 19 percent (the same as in section V), the consumption tax rate needs to be increased from to 8 to 8.85 percent in order to keep total revenue collection constant in the new steady state. The macroeconomic impact on the domestic and foreign country of such revenue-neutral tax reform is presented in Figure 4.

Figure 4. Impact of a Revenue Neutral Tax Reform



Starting with the domestic economy, it was already clear from sections IV and V that the impact of the revenue neutral tax reform would be equal to the sum of the expansionary impact of an income tax reduction (as in Figure 1(a)) and the contractionary impact of a consumption tax increase (as suggested by Figure 2(a), in which a consumption tax cut stimulates the economy). Figure 4(a) and 4(b) shows that the contractionary impact of the increase in the consumption tax rate dominates quantitatively in the short run, so that the final effect of the revenue neutral policy on the domestic economy is a reduction in output, which is only partially reversed in the medium and long run.

Figure 4(b) shows that domestic consumption excluding slightly increases. Such an increase and the consumption tax rate hike implies that domestic money demand—which is a positive function of consumption including taxes—increases. The consequent appreciation of the domestic exchange is quantitatively stronger than the one observed in the non revenue-neutral policy of section IV (compare Figures 4(c) and 1(c)). This appreciation obviously contributes to shift demand towards foreign goods, thus resulting in a temporary increase of foreign output compared to the initial steady state. Foreign agents, however, use their higher income to accumulate external assets (Figure 4(i)) rather than to increase consumption. While in this exercise domestic revenue collection is constant in the steady-state due to the policy followed by the domestic government, the impact on foreign revenue.
is positive and especially pronounced in the short run (Figure 4(f,h), due to higher foreign labor supply at an unchanged foreign tax rate. The impact on foreign tax collection is quantitatively stronger than in the case of a non-revenue neutral reduction in domestic income taxes (compare Figures 1(f,h) and 4(f,h)) due to the fact that foreign output increases

more—because of a stronger expenditure switching effect—in the revenue-neutral policy considered here.

Our exercise is similar in spirit to the one carried out by Mendoza and Tesar (1998) in an open economy RBC model with capital. The results are not directly comparable, since they look at the implications of a much more radical policy than ours, in which the US federal income tax is completely eliminated and replaced with consumption taxes. It is interesting, however, to notice that in their case—unlike in our model—this would imply a positive effect on domestic output and consumption both in the long run and along the transition path, while the impact on foreign output is positive in the short run but negative in the long run. While it is difficult to draw strong conclusions from the comparison, one possible explanation of the different results that we get is again that in our model, due to the presence of nominal rigidities, the expenditure switching effect implies that a stronger part of the benefit of income tax reductions accrues to the foreign country. This can, at least partially, explain why the domestic effect of a revenue neutral policy is expansionary in their model but contractionary in ours.

VII. Sensitivity Analysis

In this section we present the results of some sensitivity analysis. In particular, we look at how the degree of self-financing changes when we change the degree of nominal rigidity γ and the labor disutility parameter ν. Overall, our sensitivity analysis confirms the robustness of the results that we have discussed in sections IV and V.

Income Tax Cut

Table 6 shows that the results on the degree of self-financing in real terms are robust to changes in the degree of nominal rigidity in the economy. In particular, the degree of self financing of real revenue collection stabilizes around 17 percent in the new steady state regardless of the value of γ. In the case of $\gamma = 0$ the nominal degree of self-financing is zero, since in a perfectly competitive labor market with no rigidities and a unitary disutility parameter the nominal wage response is a mirror image of the increase in the labor supply stemming from the tax cut ($\hat{w} = -\hat{l}$).[14]

In Table 7 we show how our benchmark results change when we vary the labor disutility parameter along the range estimated for it by Rotemberg and Woodford (1997). Not surprisingly, Table 7 shows that a decrease in the disutility parameter of supplying labor increases the degree of self-financing of labor income tax cuts (and vice versa). Even when we set $\nu = 0.47$ (at the bottom of the range estimated by Rotemberg and Woodford (1997)), however, our estimated degree of self-financing remains close to 20 percent.

[14] This implies that the general equilibrium and the partial equilibrium effects are the same in eq. (26) because $\hat{w}$ and $\hat{l}$ compensate each other in the numerator.

Table 6. Income tax rate cut: degree of self-financing for different values of the price rigidity parameter

	Nominal overall tax revenues				Real overall tax revenues			
	t = 1	t = 3	T = 5	New steady state	t = 1	t = 3	t = 5	New steady state
γ=0	0	0	0	0	17.2	17.2	17.2	17.2
γ=0.2	-4.7	0.1	0.1	0.1	11.3	17.2	17.2	17.2
γ=0.5	-20.4	-0.4	0.4	0.5	-7.0	15.9	17.1	17.3

Table 7. Income tax rate cut: degree of self-financing for different values of the labor disutility parameter

Degree of self-financing								
	Nominal overall tax revenues				Real overall tax revenues			
	t = 1	t = 3	t = 5	New steady state	t = 1	t = 3	t = 5	New steady state
ν=0.47	-30.4	-0.9	1.0	1.2	-12.9	20.9	23.5	23.9
ν=1	-20.4	-0.4	0.4	0.5	-7.0	15.9	17.1	17.3
ν=1.67	-14.8	-0.3	0.2	0.2	-4.4	12.1	12.8	12.9

Consumption Tax Cut

In Tables 8 and 9 we present sensitivity results for changes in γ and ν in the case of the consumption tax cut. Our results are very robust to changes in the degree of nominal rigidity. The impact of changes in ν is similar to the one discussed above in the case of income tax cuts. The degree of self-financing in real terms increases for lower levels of the labor disutility parameter but remains below 20 percent (Table 9).

Table 8. Consumption tax rate cut: degree of self-financing for different values of the price rigidity parameter

	Nominal overall tax revenues				Real overall tax revenues			
	t = 1	t = 3	t = 5	New steady state	t = 1	t = 3	t = 5	New steady state
γ=0	24.2	24.2	24.2	24.2	11.6	11.6	11.6	11.6
γ=0.2	27.4	24.2	24.2	24.2	15.5	11.5	11.6	11.6
γ=0.5	37.9	24.5	24.0	23.9	27.8	12.4	13.6	11.5

Table 9. Consumption tax rate cut: degree of self-financing for different values of the labor disutility parameter

Degree of self-financing								
	Nominal overall tax revenues				Real overall tax revenues			
	t = 1	t = 3	t = 5	New steady state	t = 1	t = 3	t = 5	New steady state
ν=0.47	33.8	24.5	24.0	23.9	27.2	16.5	15.8	15.6
ν=1	39.9	24.5	24.0	23.9	27.8	12.4	11.6	11.5
ν=1.67	40.9	24.5	24.0	24.0	28.0	9.5	8.7	8.6

VII. CONCLUSIONS

This paper focuses on the impact of tax reforms in a two-country model with imperfect competition and nominal rigidities. In particular, we investigate and compare the effects of unilateral reductions in domestic income and consumption tax rates.

Our analysis shows that, for a standard parameterization, dynamic Laffer effects do not emerge following reductions in income or consumption tax rates, since total revenue collection permanently falls in both cases. This implies that in our model such tax reforms are not self-financing and therefore do not deliver a "free lunch" for the budget. We also study the degree of self-financing in the sense of Mankiw and Weinzierl (2006). Since the degree of self-financing that we derive is at the bottom of the range provided by previous literature, we conclude that not only "free lunches" do not emerge in our model, but also that the "lunches" delivered by tax cuts are not that cheap.

In addition to the budgetary impact, the tax reforms that we study also have important implications for domestic and foreign macroeconomic variables. A reduction in the domestic labor income tax rate generates a domestic boom, in which both output and consumption increase. The foreign economy is affected both in the short and in the long run through various transmission channels (an expenditure switching effect, a terms of trade effect, and a trade surplus/deficit effect).

A comparison of consumption-tax based versus income-tax based fiscal stimulus packages shows that, if a given reduction in public spending and total revenue collection is achieved by a consumption (rather than income) tax rate reduction, the impact on domestic output is larger in the very short run but smaller in the medium and long run. In a revenue-neutral tax reform, in which consumption taxes are increased to compensate the income tax reduction, the contractionary effect of higher consumption taxes dominate in the short run but is partially reversed in the long run.

The model presented in this paper could be extended in several directions. For example, rather than being restricted to balance its budget in every period, the government could be allowed to run a deficit which would result in debt accumulation. The analysis of how such a

more complicated (and realistic) menu of fiscal policy options interacts with tax rate reductions would be an interesting topic for future research.

APPENDIX

Derivation of initial share of income taxes on total taxes.

Equations (13), (17) and (20) imply that in the initial steady state we have the following equations:

$$y_0 = C_0 = l_0 = [(\frac{1-\tau_0^I}{1+\tau_0^C})(\frac{\theta-1}{\theta})]^{\frac{1}{\nu+1}} \quad \text{(A1)}$$

$$P_0 = \frac{\theta}{\theta-1} w_0 \quad \text{(A2)}$$

$$NRC_0 = \tau_0^I w_0 l_0 + \tau_0^C P_0 C_0 = \tau_0^I w_0 l_0 + \tau_0^C P_0 l_0 = (\tau_0^I w_0 + \tau_0^C P_0) l_0 \quad \text{(A3)}$$

We can therefore express the share of initial labor income taxes on total taxes as

$$u = \frac{\tau_0^I w_0 l_0}{(\tau_0^I w_0 + \tau_0^C P_0) l_0} = \frac{\tau_0^I w_0}{(\tau_0^I w_0 + \tau_0^C P_0)} \quad \text{(A4)}$$

Using the initial nominal wage as a numeraire $(w_0 = 1)$ our benchmark parameterization $(\tau_0^I = 0.2; \tau_0^C = 0.08; \theta = 11; \nu = 1)$ and equations (A1), (A2) and (A3) imply that $P_0 = 1.1$.

We can therefore evaluate (A4) numerically as

$$u = \frac{0.2}{0.2 + (0.08)(1.1)} = 0.7$$

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