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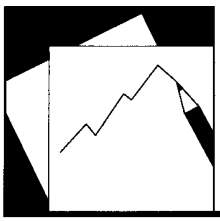

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Tariff-Tax Reforms in Large Economies

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Tariff-Tax Reforms in Large Economies

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Abstract

This paper studies tariff-tax reforms in a calibrated two-region global New Keynesian model composed of a developing and an advanced region. In our baseline calibration, a revenue-neutral reform that lowers tariffs in developing countries can reduce domestic welfare. The reason is that the increase in developing countries welfare due to higher output is dominated by the welfare losses stemming from the deterioration of the terms of trade. On the other hand, the reform increases output and welfare in the advanced countries and in the world as a whole. The effects that we highlight have not been studied in previous contributions to the literature, which typically looks at tariff-tax reforms using a small open economy framework. Nominal rigidities have important implications for adjustment dynamics in our model. In the case of a "point-for-point" reform, for example, price stickiness implies that the international dynamics of output is reversed compared to a revenue neutral reform.

JEL Classification Numbers: E62, F12, F13, F41, H20

Keywords: Tariff-tax reform; imperfect competition; trade negotiations; open economy macroeconomics; trade liberalization

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I. INTRODUCTION

Recent decades have seen increased trade integration, during which both industrialized and developing economies have reduced trade barriers and opened their markets to international competition. Many quantitative and administrative trade restrictions have been eliminated, and tariffs have been reduced in the context of multilateral WTO negotiations and of regional trade agreements, as well as following countries' unilateral decision to liberalize trade. According to a World Bank study (Finger, Ingco, and Reincke 1996; see Table 1 below) the percentage weighted average applied tariff reduction under the Uruguay Round Agreement for industrial goods ranged from zero (for countries such as Chile, Senegal, and Tunisia) to around 15 percent (Iceland, India, Sri Lanka), with an average reduction of about 6 percent for the countries considered in the study.

Table 1. Tariff Reductions under the Uruguay Round

Country	Reduction[1]
Argentina	4.9
Australia	8.2
Brazil	2.9
Canada	4.8
Chile	0.0
Colombia	3.6
Czech Republic	1.3
El Salvador	3.8
European Union	2.9
Hungary	2.8
Iceland	14.8
India	16.5
Indonesia	11.0
Jamaica	12.5
Japan	2.6
Korea	8.7
Malaysia	7.2
Mexico	0.9
New Zealand	8.2
Norway	3.5
Peru	10.8
Philippines	8.6
Poland	4.2
Romania	3.6
Senegal	0.0
Singapore	9.3
Sri Lanka	14.8
Switzerland	1.1
Thailand	13.1
Tunisia	0.0
Turkey	6.3
United States	2.9
Uruguay	9.2
Venezuela	2.5
Zimbabwe	6.0

[1] Weighted average applied tariff reduction percentage under the Uruguay Round Agreement for industrial goods. From Finger, Ingco, and Reincke (1996).

Trade liberalization seems justified on theoretical grounds. In principle, economic theory calls for small open economies to set tariffs to zero and raise revenue through consumption taxes (Dixit 1985; Diamond and Mirlees 1971). On this basis, the view that trade

liberalization enhances economic efficiency and accelerates growth is now almost universally accepted (see Escolano 1995; Ebrill *et al.*1999). In spite of this, countries are often reluctant to carry out further tariff liberalization. Resistance to further trade liberalization is underscored by the difficulties faced in concluding the Doha round of trade negotiations. Keen and Lightart (2002, 2005) argue that developing countries might be reluctant to implement further tariff reductions because of the potential revenue loss associated with this policy. This view is consistent with the analysis carried out by Mourmouras (1991), who finds that the optimal tariff level is positive in an "infant government" model of a developing country in which, due to weak capacity, collection and administration costs for income and consumption taxes are prohibitive.

The experience of developing countries with trade liberalization highlights the potential destabilizing effects of revenue losses from tariff reforms. As documented by Ebrill *et al.* (1999), early tariff liberalization efforts in Senegal in the mid-1980s were reversed, partly due to serious revenue shortfalls. Countries that were more successful in trade liberalization in the same period, such as Malawi, Morocco and the Philippines, compensated the revenue loss associated with tariff cuts by bolstering domestic revenue collection, especially in the area of consumption taxes.[1] Concerns about loss of fiscal revenues from trade taxes are likely to be exacerbated by recent tax policy trends in emerging markets and developing countries, which have seen significant reductions in corporate income tax rates and widespread use of tax incentives to attract FDI (see, for example, Keen and Simone 2004).[2] In light of these trends, countries that contemplate reducing tariffs will need to boost their ability to take timely compensating revenue measures, such as developing broad-based consumption taxes. This, of course, is a standard IMF recommendation.

Tariff-tax reforms like the one we are focusing on have mostly been implemented in developing countries. In the current macroeconomic environment, however, they might be as relevant for industrialized countries. Sharp declines in tax revenues due to deep and prolonged recessions have resulted in large public debt positions in most industrialized countries, and fiscal consolidation is now a top priority in the policy agenda. It is therefore highly unlikely that industrialized countries would reduce tariffs without increasing some other taxes to compensate for the loss in revenues.

Despite its importance in the policy arena, the analysis of integrated tariff-tax reforms has received little attention in the literature. Early theoretical analysis of piecemeal tariff reform, such as Hatta (1977) and Fukushima (1979), establish sufficient conditions under which tariff reductions improve welfare, but they do not focus on the revenue effect. Michael et al. (1993) incorporate revenue concerns in an analysis of tariff reform. They look at infinitesimal

[1] All those countries introduced a VAT during the process of trade liberalization.

[2] Another reason for which developing countries might be reluctant to further reduce tariffs is that, even though trade liberalization is likely to bring about increased overall economic efficiency and economic growth, there might be some distributional impact which could negatively affect the poorest segments of the population. In such cases, there might be a case for targeted compensating transfers from the budget. This would generate a need for additional fiscal space and would make the concerns about the loss of trade-related fiscal revenues even more pressing.

reforms in a static trade model of a small open economy, and show that a revenue-neutral tariff-tax reform, in which consumption taxes are increased to compensate for the revenue loss due to reduction in tariffs, increases welfare under fairly general conditions. Kreickemeier and Raimondos-Møller (2008) find a similar result, but qualify it by observing that the reform increases welfare by less than a piecemeal tariff reduction, and that the volume of trade might fall even as welfare increases. The result that such reforms improve welfare in a small open economy carries on to a dynamic setting. Naito (2006), for example, uses a dynamic endogenous growth model of a small open economy with a capital and a consumption good. In his framework, a revenue neutral tariff-tax reform always raises welfare (by raising future consumption) as long as the pre-reform tariff rate is positive. Ligthart and van der Meijden (2011) use a dynamic model of a small open economy with endogenous labor supply and sector-specific capital and land. They find that, following a revenue neutral tariff-tax reform, lifetime utility increases under plausible conditions, despite a fall in short run instantaneous utility.

The result that tariff reductions increase welfare in a small open economy can be seen as a direct application of the Diamond and Mirrlees (1971) theorem on the desirability of production efficiency (see also Dixit 1985)). The intuition is that the tariff is equivalent to a net subsidy to producers. Reducing this subsidy increases the value of output at current prices, thus increasing welfare. Since consumption taxes are less distortionary than tariffs, the attendant increase in consumption does not offset the welfare gains from the lower tariff.

Emran and Stiglitz (2005) provide an example of a case in which the positive welfare effects discussed above can be reversed. Using a standard static trade model, extended to allow for incomplete coverage of the consumption tax due to an informal sector, they show that revenue-neutral tariff-tax reforms reduce welfare under plausible conditions. The intuition is that in their setup an increase in the consumption tax increases the intersectoral distortions between the formal and the informal sector. The overall message emerging from the literature is that a revenue neutral tariff-tax reform typically increases welfare in a small open economy, although this result can be reverted once informality is taken into account. Although the informality issue is an important one, we see it as beyond the scope of this paper and we set it aside in our analysis.

While the papers discussed above are mostly concerned with revenue-neutral tariff tax reforms, the literature has also focused on so-called “point-for-point” reforms, under which the tariff cut is combined with an increase in the consumption tax of the same absolute magnitude. Using static small open economy models with perfect competition, Michael, Hatzipanayotou, and Miller (1993) and Keen and Ligthart (2002) show that such reforms can increase both welfare and revenue collection, as long as they leave consumer prices unchanged. This ensures that the efficiency gains from the tariff-tax reform also generate an increase in revenue, because the base of the consumption tax is broader than that of the tariff.

This result, however, can be reversed under imperfect competition. Keen and Ligthart (2005) study a point-for-point reform in a static model in which domestic firms are price setters in the international markets, due to a Cournot duopoly. In this setting, the reform unambiguously reduces domestic output and welfare.

In our analysis we focus on tariff-tax reforms using a full-fledged New Keynesian two-country model. Compared to the above mentioned papers, which use small-open economy models, our approach allows us to highlight international transmission channels and to characterize how tariff-tax reforms implemented in one country affect domestic and foreign output, consumption, and government revenue collection. Our two-country approach also allows us to focus not only on the domestic welfare impact of the reforms, but also on the foreign and global ones. This is an important difference with existing papers, which tend to focus on the domestic welfare of small open economies.

To be able to realistically analyze the dynamic effects of tariff-tax reforms, we assume that prices are sticky, while the existing papers assume flexible prices. In this way, we incorporate in the theoretical analysis of tariff-tax reform the findings of a substantial body of evidence that shows that prices are sticky in the short run (see, for example, Nakamura and Steinsson 2008 and Dhyne et al. 2006). This realistic assumption brings into the picture an important transmission channel, namely the Keynesian expenditure-switching effect of a nominal exchange rate change. This effect would not be relevant if prices were fully flexible. Price rigidities also have important implications for adjustment dynamics in our model. In the case of a "point-for-point" reform, for example, the international dynamics of output is reversed compared to a revenue neutral reform.

In addition to being interesting from the academic point of view, the issues we study are also relevant from the policy point of view, since our paper provides an evaluation of the welfare impact of a standard IMF recommendation. The international dimension of unilateral reforms is also of relevance for the current policy debate on the desirability of international coordination of national policies. In this regard, our choice to use a two-country model can also be useful to shed some light on trade relations between industrialized and developing countries. As recently stressed by *The Economist* (2011), the share of world GDP accounted for by developing countries doubled in the last twenty years, reaching 38 percent in 2010. In addition, in 2010 emerging economies' exports were about half of the world total, up from 27 percent in 1990. This rapid rise means that the bloc of developing countries can have a more significant role in international trade negotiations, since they can act as a large-country that—unlike a small open economy—can influence its terms of trade. As *The Economist* (2011) wrote: *"Two decades ago economic models treated the developing world like a dog's tail, wagged this way and that by rich countries but too small to affect them. Now the tail wags the dog"*.

In our policy exercises, we first look at a unilateral revenue neutral tariff-tax reform implemented domestically, in which the loss in revenue due to the reduction in the tariff is compensated by an increase in the consumption tax. Our baseline results show that the welfare impact of this reform is strongly driven by a terms-of-trade channel. The fact that the reduction in the domestic tariff deteriorates the domestic terms of trade, thus increasing the price paid by domestic residents for their imports, implies a reduction in domestic welfare. This happens in spite of the increase in output, because the positive welfare implications of higher output are dominated by the negative terms-of-trade effect. This finding is in sharp contrast with existing studies that typically find a positive welfare effect. However, since the

impact on foreign consumption is positive, foreign welfare increases. The latter effect is enough to compensate the fall in domestic welfare, therefore improving global welfare.

Our analysis implies that, even if revenue neutral tariff-tax reforms raise global welfare, they are costly to implement for countries whose terms of trade are affected by the reform. While those reforms are usually welfare-enhancing from the point of view of small, developing open economies, they might not be so appealing for a large developing economy or for the group of developing countries as a whole which coordinate and negotiate their trade policy vis-à-vis the advanced countries as a bloc.

In terms of comparison with the existing literature, it is important to stress that our result that domestic welfare falls is essentially due to imperfect competition and the sheer size of the economy. It is the fact that the country is large that implies a significant terms-of-trade effect. In the small open economy literature discussed above, the typical result is the opposite, since welfare generally increases following revenue neutral tariff tax reforms. Our results are consistent with empirical evidence that unilateral tariff changes can affect a country's terms of trade (Anderson and Van Wincoop 2002; Bown and Crowley 2006; see Bagwell and Staiger (2010, Section 3) for a survey of the issue). The fact that the reduction in the tariff reduces welfare suggests that, for our parameterization, the domestic economy is below its optimal tariff level.[3]

In section V, we look at a policy exercise in which, rather than increasing consumption taxes by the amount needed to perfectly offset the loss in tariff revenue, the domestic government uses a point-for-point reform similar to the one studied by Keen and Lighthart (2005). In point-for-point reforms tariff cuts are combined with one-for-one increases in consumption taxes. The tax consumption rate is therefore set at a higher level than the one needed to keep overall revenue constant. We analyze this kind of policy because of its relevance in the current policy environment. Due to the fiscal consolidation agenda, countries are likely to implement tax reforms which not only change the composition of taxation but also increase overall tax revenues. In addition, for policy communication reasons, governments are likely to use point-for-point reforms, rather than implementing changes to the tax rate up to decimal points. The fact that the domestic consumption tax is increased more than the amount needed to keep overall revenue neutral implies an important difference, compared to the revenue neutral case. Namely, domestic output and welfare and global welfare now fall. The specific policy design of a tariff-tax reform can therefore have important macroeconomic and welfare implications.

[3] Our baseline calibration assumes that the developing countries as a group start from a tariff level that is below the optimal tariff, so that a reduction in tariffs lowers domestic welfare. In a trade model without frictions, if the initial tariff level was set at a high enough level, the domestic country would find itself above its optimal tariff level and a tariff reduction would, *ceteris paribus*, improve welfare. The calculation of the optimal tariff level is left for future work.

The result that a point-for-point reform can reduce welfare in an open economy model with imperfect competition is consistent with the findings of Keen and Lighhart (2005). They show that this policy reduces domestic welfare because of higher consumer prices and lower income. The reduction in output is present also in our model. However, in our model the deterioration in the domestic terms of trade is an additional mechanism, compared to Keen and Lighhart (2005), which contributes to reducing domestic welfare. Another way in which our analysis differs from Keen and Lighhart (2005) is that we illustrate that this policy increases foreign welfare but reduces global welfare, while they only focus on domestic welfare.

The rest of the paper is organized as follows. Section II introduces the model. Section III discusses the parameterization. Section IV analyzes the international transmission a revenue-neutral tariff-tax reform. Section V presents and discusses the results in a case of a point-for-point reform. Section VI concludes the paper.

II. THE MODEL

We use a standard New Keynesian two country model, extended to incorporate import tariffs and distortionary consumption taxes. As such, our model is similar in spirit to those presented in Betts and Devereux (2000) and Ganelli and Tervala (2008).[4] 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 what follows we present the equations for the domestic country. Unless explicitly discussed, foreign equations are symmetric to domestic ones.

A. Households

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

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

where $0 < \beta < 1$ is the discount factor, C_t is a composite good representing private consumption and P_s is the price index associated with it. The expression $P(\tau^T)$ denotes the fact that P_t is a function of the trade tariff τ^T, as specified in equation (3) below. M_t denotes nominal money balances and $l_t(z)$ 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.

[4] Betts and Devereux (2000) focuses on monetary and fiscal shocks, while Ganelli and Tervala (2008) analyse the impact of income and consumption tax cuts in a model without tariffs.

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

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

where θ is the elasticity of substitution between any pair of individual goods, while the variables c_t^h and c_t^f respectively refer to consumption of domestic and foreign goods by domestic households.

One key difference with Betts and Devereux (2001) and Ganelli and Tervala (2008) is that we introduce tariffs on imported goods as in Fender and Yip (2000). We model trade policy by assuming that the domestic (foreign) country imposes a tariff on all foreign (domestically) produced goods. Under those assumptions, the domestic price index is given by

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

where $p_t(z)$ is the price of a representative domestically produced good expressed in domestic currency, $p_t^*(z)$ is the price of a representative foreign produced good expressed in foreign currency, E is the nominal exchange rate defined as the price of the foreign currency in terms of the domestic currency, and τ_t^T is the import tariff imposed by the domestic country.

The price index for the foreign country takes an analogous form

$$P_t^*(\tau^{T*}) = [\int_0^n (\frac{p_t(z)}{E_t}(1+\tau_t^{T*}))^{1-\theta} dz + \int_n^1 (p_t^*(z)^{1-\theta} dz]^{\frac{1}{1-\theta}} \quad (4)$$

where τ_t^{T*} is the import tariff imposed by the foreign country.

The optimal allocation of domestic consumption between domestic and foreign goods requires

$$\frac{c_t^h(z)}{c_t^f(z)} = \left[\frac{p_t(z)}{(1+\tau_t^T)E_t p_t^*(z)}\right]^{-\theta}$$

Analogously, the same equation for foreign consumption is

$$\frac{c_t^{f*}(z)}{c_t^{h*}(z)} = \left[\frac{p_t^*(z)}{(1+\tau_t^{T*})(1/E_t)p_t(z)}\right]^{-\theta}$$

where $c_t^{f*}(z)$ and $c_t^{h*}(z)$ respectively denote consumption of foreign and domestic goods by foreign households.

Under our assumptions, as explained also in Fender and Yip (2000), the law of one price holds for all *producer* prices, i.e. $p_t(z) = Ep_t^*(z) \forall z$, including protected goods, because the tariff does not change the elasticity of demand faced by producers. However, due to the presence of non-zero import tariffs, the law of one price does not hold for *consumer* prices. The budget constraint of the domestic representative household is given by

$$M_t + \delta_t D_t = D_{t-1} + M_{t-1} + w_t l_t(z) - (1+\tau_t^C) P_t(\tau^T) C_t + \pi_t + P_t(\tau^T) T_t \tag{5}$$

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^C is the tax rate on consumption, and T_t denotes real transfers from the government. Given that bonds are denominated in domestic currency, the budget constraint of the foreign representative household is

$$M_t^* + \delta_t \frac{D_t^*}{E_t} = \frac{D_{t-1}^*}{E_t} + M_{t-1}^* + w_t^* l_t^*(z) - (1+\tau_t^{C^*}) P_t^*(\tau^{T^*}) C_t^* + \pi_t^* + P_t^*(\tau^{T^*}) T_t^* \tag{6}$$

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 (5), and an analogous optimization problem holds for foreign households. The resulting first order conditions are

$$\delta_t (1+\tau_{t+1}^C) P_{t+1}(\tau^T) C_{t+1} = \beta (1+\tau_t^C) P_t(\tau^T) C_t \tag{7}$$

$$\delta_t (1+\tau_{t+1}^{C^*}) P_{t+1}^*(\tau^{T^*}) C_{t+1}^* E_{t+1} = \beta (1+\tau_t^{C^*}) P_t^*(\tau^{T^*}) C_t^* E_t \tag{8}$$

$$l_t^v(z) = \frac{1}{(1+\tau_t^C)} \frac{w_t}{C_t P_t(\tau^T)} \tag{9}$$

$$l_t^{*v}(z) = \frac{1}{(1+\tau_t^{C^*})} \frac{w_t^*}{C_t^* P_t^*(\tau^{T^*})} \tag{10}$$

$$\frac{M_t}{P_t(\tau^T)} = \left(\frac{\chi(1+\tau_t^C) C_t}{1-\delta_t}\right)^{\frac{1}{\varepsilon}} \tag{11}$$

$$\frac{M_t^*}{P_t^*(\tau^{T*})} = \left(\frac{\chi(1+\tau_t^{C*})C_t^*}{1-\frac{\delta_t E_{t+1}}{E_t}}\right)^{\frac{1}{\varepsilon}} \tag{12}$$

Equations (7) and (8) 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 (9) and (10) 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 (9) and (10) show that higher consumption taxes reduce labor supply for given levels of the real wage and consumption. Tariffs have the same effect through their impact on price indexes: higher tariffs mean higher prices faced by consumers, which as shown in equations (9) and (10), reduce labor supply *ceteris paribus*. Finally, equations (11) and (12) 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 consumption taxes and tariff revenues or seignorage.[5] 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 be written as

$$P_t(\tau^T)T_t = P_t(\tau^T)\tau_t^C C_t + R_t + M_t - M_{t-1} \tag{13}$$

where R_t denotes domestic revenue from import tariffs defined, in a symmetric equilibrium, as

$$R_t = \tau_t^T c_t^f(z) p_t^*(z) E_t$$

the expression above shows that domestic tariff revenues depend on the tariff rate, on consumption of foreign goods by domestic households and on their price expressed in domestic currency.

Similarly, foreign revenue from import tariffs can be shown to be equal to

$$R_t^* = \tau_t^{T*} c_t^{h*}(z) p_t(z)(1/E_t) .$$

Both the tariff rate and the consumption tax rate follow an AR(1) process

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

$$\hat{\tau}_t^i = \rho_i \hat{\tau}_{t-1}^i + \varphi_{i,t}$$

where i=T,C, $\rho_i \in [0,1]$ and $\varphi_{i,t}$ is a zero mean white-noise process that represents an unexpected change to the tariff or consumption tax rate. Percentage changes from the initial steady state (denoted by the subscript zero) are denoted by hats (for example: $\hat{\tau}_t = \frac{d\tau_t}{d\tau_0}$).

In practice, tax and tariff rates are very stable and can only be changed through policy decisions. In the policy exercises that we carry out in this paper we therefore set the persistency parameter $\rho_i = 1$, while the parameter $\varphi_{i,t}$ is used to model policy shifts. Setting $\rho_i = 1$ is consistent with the Barro's tax-smoothing model of government finance, which predicts that taxes should follow a random walk (Barro 1981).

C. Firms

Technology

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

$$y_t(z) = l_t(z) \tag{14}$$

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

Profits

Profits of the representative domestic and foreign firms, respectively, are given by

$$y_t(z) = p_t(z) y_t(z) - w_t l_t(z) \tag{15}$$

$$y_t^*(z) = p_t^*(z) y_t^*(z) - w_t^* l_t^*(z) \tag{16}$$

We assume that each firm enjoys a certain degree of monopolistic power in the production of its differentiated good. Under this assumption and taking into account the import tariff structure, demand for the output of the representative domestic firm which produces a particular domestic good z is given by

$$y_t^d(z) = \left(\frac{p_t(z)}{P_t(\tau^T)}\right)^{-\theta} nC_t + \left[\frac{p_t(z)(1+\tau_t^{T^*})}{E_t P_t^*(\tau^{T^*})}\right]^{-\theta} (1-n) C_t^* \tag{17}$$

using (14) and (17) domestic profits can be written as

$$\pi_t(z) = [p_t(z) - w_t] \left\{ \left(\frac{p_t(z)}{P_t(\tau^T)}\right)^{-\theta} nC_t + \left[\frac{p_t(z)(1+\tau_t^{T^*})}{E_t P_t^*(\tau^{T^*})}\right]^{-\theta} (1-n) C_t^* \right\} \tag{18}$$

while foreign profits can be written in an analogous way as

$$\pi_t^*(z) = [p_t^*(z) - w_t^*]\left\{[\frac{E_t p_t^*(z)(1+\tau_t^T)}{P_t(\tau^T)}]^{-\theta} nC_t + [\frac{p_t^*(z)}{P_t^*(\tau^{T*})}]^{-\theta}(1-n)C_t^*\right\} \tag{19}$$

Price Setting

Under perfectly flexible price, domestic firms would simply maximize (17) with respect to $p_t(z)$. The solution to this optimization problem is

$$p_t(z) = \frac{\theta}{\theta - 1} w_t \tag{20}$$

Equation (20) states that the price of each differentiated good is determined by the marginal cost faced by the firm and by a mark-up which depends on the degree of monopolistic competition in the economy.

However, following Calvo (1983), we introduce nominal rigidities by assuming that each firm changes its price with a probability $1-\gamma$ in each period, independently of other firms and independently of the time passed since the last adjustment. Under these assumptions 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 therefore 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

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

where $\zeta_{t,s}$ is the stochastic discount factor between period t and period s. The result is the following pricing rule

$$p_t(z) = (\frac{\theta}{\theta - 1}) \frac{\sum_{s=t}^{\infty} \gamma^{s-t} \zeta_{t,s} Q_s w_t}{\sum_{s=t}^{\infty} \gamma^{s-t} \zeta_{t,s} Q_s} \tag{21}$$

$$\text{where } Q_t = (\frac{1}{P(\tau^T)})^{-\theta} nC_t + (\frac{1+\tau_t^{T*}}{E_t P_t^*(\tau^{T*})})^{-\theta}(1-n)C_t^*$$

The log-linear version of equation (21) can be written as

$$\hat{p}_t(z) = \beta\gamma \hat{p}_{t+1}(z) + (1 - \beta\gamma)\hat{w}_t$$

The previous expression shows that the change in the optimal price can be approximated by a weighted average of the changes in current and future marginal costs.

D. The Consolidated Budget Constraint

By substituting equations (13) and (15) into (5) we get the consolidated budget constraint for the domestic economy

$$\delta_t D_t = D_{t-1} - P_t C_t + p_t(z) y_t(z) \tag{22}$$

where P_t is the domestic price index without tariffs defined as

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

The consolidated budget constraint of the foreign economy can be expressed as

$$-\frac{n}{1-n}\delta_t \frac{D_t}{E_t} = -\frac{n}{1-n}\frac{D_{t-1}}{E_t} - P_t^* C_t^* + p_t^*(z) y_t^*(z) \tag{23}$$

E. 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). Under this assumption, using the zero subscript to denote the initial steady state, equation (22) implies that $C_0 = y_0$. Combining this result with equations (9), (14) and (20), we can show that

$$l_0(z) = C_0 = y_0(z) = \left[\frac{(\theta-1)p_0(z)}{\theta P_0 (\tau^T)(1+\tau_0^C)}\right]^{\frac{1}{1+\nu}} \tag{24}$$

Equation (24) above show the distortionary effect of tariff and consumption taxes: increasing these policy variables reduces the steady state levels of labor supply, thus lowering output and consumption. A similar role is played by the elasticity of substitution parameter θ. As θ approaches its lower bound ($\theta \to 1$), the elasticity of substitution between goods decreases, implying an increase in the monopolistic power of each firm. A lower θ therefore means a larger deviation from the perfect competition case, which implies a lower level of steady-state output and consumption.

Equilibrium is defined as sequences of variables that clear the labor, goods and money markets in each country in each period and satisfy intertemporal budget constraints and pricing rules.

III. PARAMETERIZATION

The parameterization of the model, summarized in Table 2, is chosen to match characteristics of developing countries. We interpret periods as quarters. Therefore, we set the discount factor β to 0.99, implying a steady-state real interest rate of about 4 percent. The countries are assumed to be of equal size, implying n=0.5. The consumption elasticity of money demand $1/\varepsilon$ is set to 1, based on the empirical estimates of Mankiw and Summers (1986). The labor disutility parameter ν is assumed to be unitary. This implies that the Frisch elasticity of labor supply ($1/\nu$) is also set to one, a value consistent with the empirical findings of Kimball and Shapiro (2008). The Calvo price rigidity parameter is set at $\gamma = 0.5$. The average price duration $1/(1-\gamma)$ implied by this value is two quarters. This degree of price rigidity is commonly used in the business cycle literature and is consistent with the empirical estimates of Bils and Klenow (2004).

The elasticity of substitution between differentiated goods θ is set to 11. This implies a 10 percent markup in the steady state, consistent with the estimates of Basu and Fernald (1997). Our chosen value is at the top of the 6 to 11 range typically used in the literature for θ. This parameterization implies that the ratios of tariff revenue and exports to output match those of developing countries, while a lower θ would have generated unrealistically high ratios.

While for all the parameters discussed above there is a certain degree of consensus in the literature, the choice of our initial levels of tariff and consumption tax rates warrants some more detailed explanation. In practice, tariff and consumption tax rates vary greatly across countries. Average tariff rates in industrialized countries after the Uruguay Round have been between 2 and 12 percent, while they have been generally higher (up to 30 percent in some cases) in developing countries. Clemens and Williamson's (2004) find that the average tariff rate in a group of 34 mostly industrialized countries in the 1990s was in the 7-10 percent range. As a consequence of the high empirical dispersion of tariff rates, a wide range of estimates have been used in numerical simulations. Rutherford and Tarr (2002), for example, use a tariff rate of 20 percent, while Yu and Zhang (2011) choose values in the 3.5-10 percent range. Ligthart and van der Meijden (2011) use a tariff rate of 15 percent for consumption goods in the analysis of a tariff-tax reform in a small developing country.

We set the initial level of the tariff rate at 10 percent. This is somewhat higher that Clemens and Williamson's (2004) most recent estimate, but can be justified on the ground that their group of countries consist mostly of industrialized countries in which tariffs are typically lower. On the other hand, by choosing 10 percent and avoiding setting the initial tariff closer to the higher levels observed in some developing countries, we also seek not to bias our results in the direction of overemphasizing the welfare impact of tariff reductions. As equation (24) illustrates, if the initial levels of tariffs were set too high, the initial level of output (equal to consumption and employment in the initial steady state) would become very

small. Under such initial conditions, a tariff reduction policy would imply an unrealistically large impact on welfare. This argument calls for using some caution, and avoiding setting the initial rates at the top of the values observed empirically. In addition, as discussed below, a 10 percent tariff rate implies a realistic tariff revenue to output ratio.

Empirical estimates of effective consumption tax rates for developing countries are rare. Gordon and Li (2009) find that in a group of 26 developing countries the average statutory VAT rate is 15 percent. However, effective tax rates are likely to be smaller than statutory ones. Portes (2009), for example, calculates the effective consumption rate in Mexico to be 8 percent. Due to the scarcity of empirical estimates of consumption tax rates in developing countries, we briefly compare here these estimates with the ones available for advanced countries. Carey and Rabesona (2002) calculate the average effective consumption tax rates for the US, Japan and the EU-15 countries to be 10 percent during 1990-2000. Our choice of a 10 percent initial consumption tax rate is consistent with their estimates. A 10 percent consumption tax rate is also used by Basdevant et al. (2012) for a group of developing countries, while Ligthart and van der Meijden (2011) use 9 percent for a typical developing country. Finally, as already discussed in section II.B, the parameters governing the persistence of the tariff and tax rate changes are set to one ($\rho_T = \rho_C = 1$). This implies that policy changes in the rates are permanent.

Our parameterization implies, together with the fact that prices ($p_0(z)$ and $p_0^*(z)$) are normalized to one, an initial level of tariff revenue to output of about 5 percent. Gordon and Li (2007) use a group of 125 countries to calculate tax revenues relative to gross domestic product and tariff revenue relative to total revenue (see their Table 1.2). Their calculations imply that tariff revenue is on average about 4 percent of GDP for the countries that they consider. Tariff revenue, however, is typically higher in developing countries. Therefore, our parameterization generates a quite realistic tariff revenue to output ratio. The ratio of consumption tax revenue to output ratio in our model is also realistic. At 10 percent, our consumption revenue to output ratio is broadly line with the evidence provided by Norregaard and Khan (2007), who find that revenue from consumption-based taxes was 9 percent in Latin American and Caribbean countries.

In addition to generating realistic revenue to output ratios, our parameterization implies that the initial export to output ratio is also in line with those observed in developing countries. In our model such ratio is 26 percent, a value close to ones observed empirically. According to the World Bank (2011), for example, the export-to-GDP ratio in low and middle income countries averaged 30 percent in 2005-2010, while Ligthart and van der Meijden (2011) find that the 10-year average share of manufacturing imports in GDP is 24 percent for low-income countries.

Table 2. Model Parameterization

Parameter	Value	Description
β	0.99	Discount factor
ε	1	Inverse of the consumption elasticity of money demand
ν	1	Labor supply elasticity
θ	11	Elasticity of substitution between goods
γ	0.5	Calvo-parameter
n	0.5	Relative size of the domestic economy
τ^T	0.1	Initial tariff rate
τ^C	0.1	Initial consumption tax rate
ρ_T , ρ_C	1	Persistence of the tariff and tax shocks
$\varphi_{T,1}$	-0.1	Size of the tariff shock

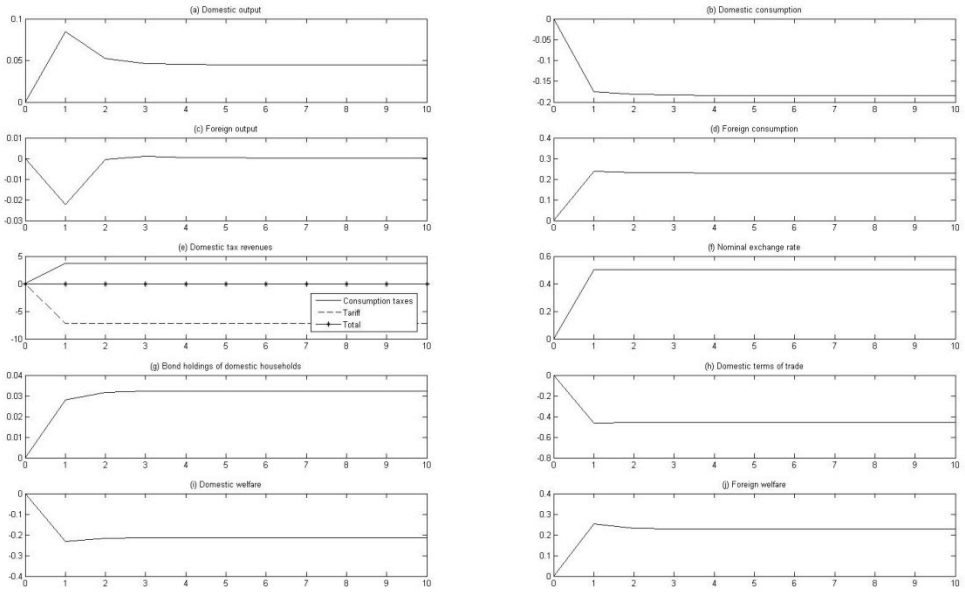
IV. REVENUE NEUTRAL TARIFF-TAX REFORM

In this section we analyze the implications of a tariff-tax reform implemented by the domestic country. It is, however, worth observing that the effects of a foreign tariff-tax reform would be identical to that of the domestic reform.[6] The domestic tariff rate is reduced from 0.1 (a 10 percent tariff) to 0.09 (a 9 percent tariff). This corresponds to a 10 percent reduction in the rate, and is modeled by setting the parameter $\varphi_{T,t}$, which accounts for policy changes in tariffs, equal to -0.1 at the time of the reform. The consumption tax rate is increased by the amount needed to compensate the long-run revenue loss stemming from lower tariffs. Given our benchmark parameterization, the consumption tax rate needs to be increased from to 10 to 10.4 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 tariff-tax reform is presented in Figure 1 below. In all figures, the horizontal axes show time and the vertical axes show percentage deviations from the initial steady state. An exception is the change in bond holdings of domestic household (whose initial value is zero), which is expressed as a deviation from initial consumption.

[6] The only asymmetry in the model is that the only internationally traded asset, the domestic nominal bond, is denominated in domestic currency. However, due to the setting of ε = 1, nominal interest rates are equalized across countries and consequently realized returns on the international bond are also equalized across countries. The real interest rates can diverge across countries in the short run due to violations of the law of one price caused by tariffs. This short-run deviation of interest rates is however, perfectly symmetric under domestic and foreign shocks. Therefore the model behaves as if countries were perfectly symmetric and the effects of foreign tariff-tax reform would be identical to those of the domestic reform.

Figure 1. Effects of a Domestic Revenue Neutral Tariff-Tax Reform



Most of the variables presented in Figure 1 have already been defined. Before proceeding with our analysis, we need to clarify below how we define the domestic terms of trade (Figure 1(h)), the domestic tax revenues (Figure 1(e)) and how we carry out our welfare analysis (Figures 1(i) and 1(j)). The domestic terms of trade are defined as the relative producer price of domestic exports in terms of imports. Thus, the domestic terms of trade deteriorates if this index falls. The change in the terms of trade is given by

$$\hat{T}oT_t = \hat{b}_t(z) - \hat{E}_t - \hat{b}_t^*(z),$$

where $\hat{b}_t(z)$ and $\hat{b}_t^*(z)$ are the Calvo-weighted prices of domestic and foreign goods (excluding consumption taxes and tariffs) respectively, which can be written as

$$\hat{b}_t(z) = \gamma\hat{b}_{t-1}(z) + (1-\gamma)\hat{p}_t^h(z)$$

and

$$\hat{b}_t^*(z) = \gamma\hat{b}_{t-1}^*(z) + (1-\gamma)\hat{p}_t^{*f}(z).$$

The change in total tax revenues is

$$\hat{T}R_t = u\left(\hat{P}_t(\tau^T) + \hat{\tau}_t^C + \hat{C}_t\right) + (1-u)\left(\hat{\tau}_t^T + \hat{c}_t^f(z) + \hat{p}_t^*(z) + \hat{E}_t\right) \tag{25}$$

where *u* denotes the share of consumption tax revenues on total taxes in the initial steady state defined as

$$u = \frac{P_0(\tau^T)\tau_0^C C_0}{P_0(\tau^T)\tau_0^C C_0 + \tau_0^T c_0^f(z) p_0^*(z) E_0}$$

Our parameterization implies, together with the fact that prices ($p_0(z)$ and $p_0^*(z)$) and are normalized to one, that this share is equal to 0.66. In equation (25) TR refers to *total* revenue collection. The term $\left(\hat{P}_t(\tau^T) + \hat{\tau}_t^C + \hat{C}_t\right)$ denotes the change in consumption tax collection, while the term $\left(\hat{\tau}_t^T + \hat{c}_t^f(z) + \hat{p}_t^*(z) + \hat{E}_t\right)$ denotes the change in tariff revenue.

We carry out our welfare analysis by looking at the combined impact of the changes in individual macroeconomic variables on private utility. We first study the change in period-by-period utility. Then we calculate the Discounted Present Value (DPV) of these changes.[7]

The change in domestic utility in period *t* is given by

$$dU_t = \hat{C}_t - l_0^{\nu+1}\hat{l}_t \tag{26}$$

while an analogous expression holds for foreign utility.[8] Figure 1(i) illustrates the response of domestic period-by-period utility (dU_t), while Figure 1(j) presents the response of the same variable for the foreign country. The DPV of the change in utility is calculated on the basis of the following equation[9]

$$dU_{DPV} = \sum_{s=t}^{\infty} \beta^{s-t} dU_s \tag{27}$$

with an equivalent expression holding for the foreign country. Given equations (26) and (27), the change in world utility can be defined as the population weighted average of the change in domestic and foreign utility

$$dU_{DPV}^W = n dU_{DPV} + (1-n) dU_{DPV}^*$$

The impact of a the domestic tariff-tax reform on the DPV of domestic, foreign, and world utility at different time horizons is shown in Table 3 below.

The welfare results shown in Figure 1 and Table 3 are strongly driven by the terms-of-trade channel. This is because the domestic country can affect the world demand for the goods that

[7] The same welfare method in used in Ganelli and Tervala (2010).
[8] As customary in this literature, we neglect the utility derived from real balances.
[9] We approximate the infinite-time horizon by including a large number of periods (3,000) in Equation (27).

it imports. By imposing a tariff, the domestic country reduces the world demand for such imports, therefore reducing the price that it pays for them and improving its terms of trade. This explains why the domestic terms of trade deteriorate (Figure 1(h)).

Even though the terms-of-trade channel is not the only one driving the results presented in Figure 1, it is the dominating one. If it was carried out in isolation, the increase in domestic consumption taxation would decrease both domestic and foreign consumption. The fall in domestic consumption, however, would be larger than the fall in foreign consumption, because foreign residents would experience only an indirect effect—reduced demand for their exports—while domestic residents would be more directly affected, since their lifetime wealth would be reduced because of higher taxes.[10]

As Figure 1 (b) shows, domestic consumption falls under the reform that we are considering in this section. This is because the deterioration in the domestic terms-of-trade (due to the tariff reduction) and the increase in the domestic consumption tax both go in the direction of reducing domestic consumption.[11] For the foreign country, the terms-of-trade effect stemming from the tariff cut trumps the effect of higher domestic consumption taxes. While the latter, for the reasons discussed above, tends to reduce foreign as well as domestic consumption, the overall impact of the reform on foreign consumption is positive (Figure 1(d)).

The exchange rate impact of the reform is determined through its effect on the demand and supply of money in each country. As it is clear from equation (11), the reduction in the domestic tariff has a negative indirect effect on domestic money demand, due to the reduction in domestic consumption (Figure 1(b)). Equation (12) shows that the reduction in the domestic tariff also has an indirect positive effect on foreign money demand, because foreign consumption increases (Figure 1(d)). The increase in foreign consumption means that domestic consumption falls not only in absolute terms, but also in relation to foreign consumption. This relative consumption dynamics creates depreciating pressures for the domestic currency, because it implies that domestic money demand falls compared to foreign. Equation (11) also shows that the reduction in the domestic tariff has a direct positive effect on real domestic money supply, because a lower domestic tariff implies lower domestic prices, which in turn increase real money supply. This creates additional pressures for depreciation of the domestic currency.

On the other hand, the increase in domestic consumption taxes needed to compensate for the lower tariff revenues has a direct positive effect on domestic money demand (as equation

[10] See Ganelli and Tervala (2008) for an analysis of consumption tax effects consistent with the ones described here.

[11] The simultaneous increase in the consumption tax does not offset the impact of changes in tariff policies on the terms of trade. This is due to the fact that, with no home-bias, domestic consumption includes both domestic and foreign goods. Changes in domestic consumption tax rates therefore affect in the same way both the domestic country's exports and its imports.

(11) shows, money demand is a positive function of consumption *including* taxes). This effect tends to appreciate the domestic currency, and therefore goes in the opposite direction compared to the depreciating effects discussed in the previous paragraph. As Figure 1(f) shows, the overall impact of the reform that we are considering in this section is a depreciation of the domestic nominal exchange rate (E increases, i.e. more unit of domestic currency are needed to buy one unit of foreign currency). The depreciating effects discussed in the previous paragraphs therefore dominate.

The fact that the domestic exchange rate depreciates implies an expenditure switching effect: domestic goods tend to become cheaper compared to foreign in the short run, while prices are sticky. This explains the short-run increase (decrease) in domestic (foreign) output relative to the new steady state (Figure 1(a,c)).

While the impact on output of the exchange-rate expenditure switching effect is felt mostly in the short run, the welfare effects are mostly driven by the terms-of-trade channel. The deterioration in the domestic terms of trade imply that, following the tariff-tax reform, domestic residents need to work more—which is reflected in the permanently higher level of domestic output compared to the initial steady state (Figure 1 (a)) —to be able to afford a level of consumption lower than the one they could afford before the reform (Figure 1(b)). This dynamics of consumption and leisure explains the drop in period-by-period domestic welfare (Figure 1(i)).

The deterioration of the domestic terms of trade implies by definition an improvement in the terms of trade of the foreign country. This explains why the residents of the foreign country can increase their consumption (Figure 1(d)) without having to permanently work more. Indeed, they can even afford a reduction in their supply of labor in the short run (Figure 1(c)). This dynamics of foreign leisure and consumption is reflected in an increase in foreign period-by-period welfare (Figure 1(j)).

Table 3. Impact of a domestic tariff-tax reform on the DPV of domestic, foreign and world utility at different time horizons

dU_1	dU_1^*	dU_1^W	dU_{20}	dU_{20}^*	dU_{20}^W	dU_{DPV}	dU_{DPV}^*	dU_{DPV}^W
-023	0.25	0.011	-0.21	0.23	0.0082	-21.3	22.9	0.83

As it can be seen from Table 3, the fall in the DPV of domestic welfare is quite substantial, amounting to 0.21 percent in the 20th period, and to 21 percent (in discounted present value terms) over the infinite-time horizon.

However, the increase in the DPV of foreign welfare is strong enough to compensate for the fall in domestic welfare. Overall, the reform increases global welfare both in the short run and in the long run. The latter result can intuitively been explained as follows. As shown in equation (24), in the initial steady state, the world economy is at an inefficiently low level of output and consumption, due to the presence of imperfect competition and distortionary

(tariff and consumption) taxation.[12] The tax reform that we are implementing has the effect of increasing foreign consumption by an amount that is, in absolute value, bigger than the fall in domestic consumption. The word economy as a whole is therefore taken by this policy closer to the efficient level of consumption—the one which would arise in the absence of any distortion—thus improving global welfare. Another view of this is that, from the point of view of the global economy, the reduction in distortions due to the cut in the tariff is stronger than the increase in distortions generated by higher consumption taxes.

As we have already discussed above, this result for the global economy masks international differences, since the welfare of the country which implements the tariff-tax reform falls. This result is related to what has been called the "optimal tariff" argument in the trade literature.[13] Since a large economy can improve its terms of trade by imposing a tariff and thus improve welfare, it has no incentive to unilaterally implement a tariff-tax reform, even if this policy increases global welfare. One policy implications of our finding is that revenue neutral tariff-tax reforms might be costly to implement for countries that are large enough to affect their terms of trade, even if they raise global welfare. In addition, while those reforms might be acceptable for small countries acting in an uncoordinated way, they might become unpalatable—from the welfare perspective—for a group of countries (for instance, developing countries) who manage to coordinate and negotiate trade policy as a bloc.

Since the welfare result of a tariff-tax reform depends on the effect of a tariff reduction on the terms of trade, it is reasonable to ask whether tariffs can affect the terms of trade in practice. Bagwell and Staiger (2010, Section 3) briefly survey empirical work that addresses the relationship between tariffs and the terms of trade. They conclude that the empirical evidence support the view that unilateral tariff changes can significantly affect a country's terms of trade.

We now compare our results with those of the previous literature reviewed in the introduction. It is important to stress that in most of those papers our results that a revenue neutral tariff-tax reform reduces welfare does not emerge. This is because the small open economy framework used in previous papers does not allow for the terms-of-trade effect that we highlight. The only example in the literature, that we are aware of, in which a revenue neutral reform can plausibly reduce welfare is provided by Emran and Stiglitz (2005). In their paper, the mechanism which generates welfare reducing reforms is different from the ones that we stress here. In addition, while they look at several interesting questions that we do not consider, their small open economy setup does not allow an analysis of the impact of the domestic reform on foreign and global welfare.[14] The latter is another original

[12] Equation (24) only shows the steady state for the domestic economy. Given our assumptions, a symmetric equation holds for the foreign economy.
[13] The optimal tariff argument dates back to Bickerdike (1906).
[14] An important caveat on the analysis provided by Emran and Stiglitz (2005) is that the way in which they model consumption taxes is very different from a real world Value Added Tax (VAT) in that they assume (in their algebra,) that the VAT is not applied to imports (unlike a real VAT). See also Keen (2008) for a discussion.

contribution of our paper, which allows us to emphasize the tensions between the negative impact on domestic welfare and the positive impact on foreign and global welfare.

Sensitivity analysis

The trade policy literature has shown that results can be sensitive to the elasticity of substitution between domestic and foreign goods. We therefore carried out a sensitivity analysis to assess whether the main (welfare) results of this paper are significantly affected by changes in this parameter. The empirical literature shows a wide range of estimates for it. Sutherland (2006) argues that typical estimates for the average elasticity across all traded goods are in the range of 5 to 6. Feenstra, Obstfeld and Russ (2011) find that the median estimate of the micro elasticity between domestic and foreign countries is roughly 3. Based on these arguments and estimates, in our sensitivity analysis we set the elasticity to 3 and 6.

Columns I, II, and III of Table 4 shows the dependence of the sign of the welfare effect of a domestic revenue-neutral tariff-tax reform on the elasticity of substitution between domestic and foreign goods.[15] Table 4 shows the robustness of our finding that the domestic tariff-tax reform reduces domestic welfare, but increases foreign welfare. In addition, column IV of Table 4 shows that the assumption of sticky prices is not relevant for the welfare results of tariff-tax reforms. Price rigidities cause adjustment dynamics in the short run, but does not change the welfare results qualitatively.

Table 4. Sensitivity analysis:
The sign of the welfare effect of a domestic tariff-tax reform

	I	II	III	IV
	θ=3, γ=0.5	θ=6, γ=0.5	θ=11, γ=0.5 (benchmark)	θ=11, γ=0
dU_{DPV}	+	+	+	+
dU^{*}_{DPV}	-	-	-	-

V. POINT-FOR-POINT TARIFF-TAX REFORM

In this section, we look at the effects of a point-for-point reform in which the domestic country reduces the tariff from 10 to 9 percent and increases the consumption tax rate from to 10 to 11 percent. The main reason for which we focus on this reform is that it is relevant in the current global economic environment, in which fiscal consolidation is high in the policy agenda. Countries are therefore likely to change the consumption tax rate in a way that increases—rather than keeping constant—overall revenues. Even in the absence of fiscal consolidation concerns, governments are usually more likely to approximate changes in the consumption tax rate to an exact percentage point, rather than implementing changes up to a

[15] We focus on the sign because the parameter determines also the initial level of output and employment, implying that a given change in consumption has a much stronger effect on welfare if the initial level of output is low.

decimal point. This is probably due to the fact that point-for-point changes are easier to communicate to the public. Since a one-percentage point increase in the consumption tax is larger than the one needed to keep revenue constant in the previous section, we expect a point-for-point reform to increase revenue.

The macroeconomic and welfare effects of this reform are illustrated in Figure 2 and Table 5 below. The main difference between this reform and the revenue neutral one is that now, due to the point-for-point approach, the total (tax plus tariff) domestic revenue burden increases by 3.8 percent, rather than being constant as in section IV (compare Figure 2(e) with Figure 1(e)). While the main transmission mechanism is still the terms of trade one, some important differences need to be highlighted between the point-for-point and the revenue neutral reforms.

As it is clear from a comparison of figure Figure 2(a,c) with Figure 1 (a,c), the international dynamics of output is reversed compared to the revenue neutral reform: now domestic output falls while foreign output temporarily increases. This result is due to the fact that we have nominal rigidities in our model and, to the best of our knowledge was not observed in previous literature.

The fact that domestic output falls in the long run is due to a "disincentive effect" to supply labor generated by higher consumption taxes. As it can be seen from the labor-leisure trade off equation (9), a higher domestic consumption tax rate reduces, *ceteris paribus*, the amount of labor supplied by domestic residents. This is because the marginal utility that an additional unit of labor can buy (which depends on consumption excluding taxes) is reduced when taxes are increased. Domestic residents therefore react to an increase in taxes by reducing their labor supply to realign the disutility from having to supply labor with the (lower) consumption utility that labor can buy.

The fact that domestic output falls more in the short run than in the long run (Figure 2(a)) can be explained by the effect of changes in the real wage on the labor supply. The dynamics of the real wage is different in the short run, compared to the long run. While in the long run prices fall, due to the fall in domestic output, in the short run prices are sticky and do not fall. In addition, the depreciation of the domestic currency increases the price of foreign goods, which enter the domestic price index. This imported inflation makes domestic prices temporality higher in the short term. As a consequence, the domestic real wage in temporarily low. Through the labor-leisure trade-off equation (9), this makes the disincentive effect stronger in the short run than in the long run. This effect dominates the expenditure switching effect—which would imply a short-run expansion of domestic output—and explains why domestic output falls by more in the short run than in the long run. A symmetric argument explains why foreign output temporarily increases. The short-run appreciation of the foreign currency temporarily increases the foreign real wage, therefore increasing foreign labor supply and output in the short run.

The fact that the increase in the domestic consumption tax rate is larger than in section IV implies that domestic consumption falls more compared to the revenue neutral reform. In terms of effects on the money demand, the stronger depreciating effect of lower domestic

consumption is more than compensated by a stronger appreciating effect of the higher consumption tax rate.[16] The domestic exchange rate therefore depreciates less in the point-for-point reform studied here than in the revenue neutral reform.

Figure 2 and Table 5 show that the point-for-point tariff-tax reform substantially reduces domestic welfare. First, a fall in output reduces income and consequently consumption and welfare. Second, the reduction in the tariff rate implies a large deterioration of the domestic terms of trade, which brings about a large decrease (increase) of domestic (foreign) consumption, thus decreasing (increasing) domestic (foreign) welfare. The terms of trade channel is very strong and drives the welfare results. As it can be seen from Table 5 below, the effect of this policy on the DPV on domestic welfare is even more negative than in the case of the revenue neutral reform (a 30 percent loss compared to about 21 percent). This is because, compared to the revenue neutral reform, domestic output falls. Since the fall in output reduces consumption more than labor supply, domestic welfare also falls. As in the case of the revenue neutral reform, the impact on foreign utility is still positive, albeit by less than in Section IV. The lower positive foreign utility and the higher negative domestic utility imply that the DPV of world utility becomes slightly negative, rather than being positive as in the case of the revenue neutral reform.

The fall in global welfare can be explained with an argument somewhat symmetric to the one used in section IV. In this case, the fall in domestic consumption is larger (in absolute value) than the increase in foreign consumption. The point-for-point tariff-tax reform that increases total tax burden takes the global economy even further away from the efficient consumption level, and is therefore welfare decreasing.

Overall, this section has shown that the specific policy design of a tariff-tax reform can have important macroeconomic and welfare implications. In particular, using a point-for-point approach, rather than increasing the consumption tax rate just by the amount needed to keep overall revenue constant, can reduce domestic and global welfare.

The result that domestic welfare falls following a tariff-tax reform is at odds with the conventional wisdom in the literature, which usually stresses the welfare improving aspects of reform in which tariffs are reduced. In particular, Keen and Ligthart (2002) find that a point-for-point reform increases domestic welfare in a static trade model with perfect competition. On the other hand, Keen and Ligthart (2005) show that, once a duopolistic structure is allowed in a static trade model, a point-for-point reform can reduce domestic welfare because of higher consumer prices and lower income. This is consistent with our findings, since in our model the domestic welfare loss is partly caused by the reduction in output. This result is reassuring, in the sense that it confirms, in a dynamic setting, the finding by Keen and Ligthart (2005) that deviations from perfect competition can reverse the welfare-enhancing properties of tariff-tax reforms. Compared to Keen and Ligthart (2005), we also show that in imperfectly competitive large economies there is an additional

[16] As discussed in section II.A, money demand is a positive function of consumption including taxes (see equation 11).

mechanism that contributes to the reduction domestic welfare: a deterioration in the terms of trade caused by the reduction in tariffs. In addition, while the small open economy framework used by Keen and Ligthart (2002, 2005) implies that they can only focus on domestic welfare, our two-country framework allows us to show that the point-for-point reform increases foreign welfare, but reduces global welfare. To the best of our knowledge, the latter is also a result which was not observed in previous literature.

Figure 2. Effects of a Domestic Point-For-Point Tariff-Tax Reform

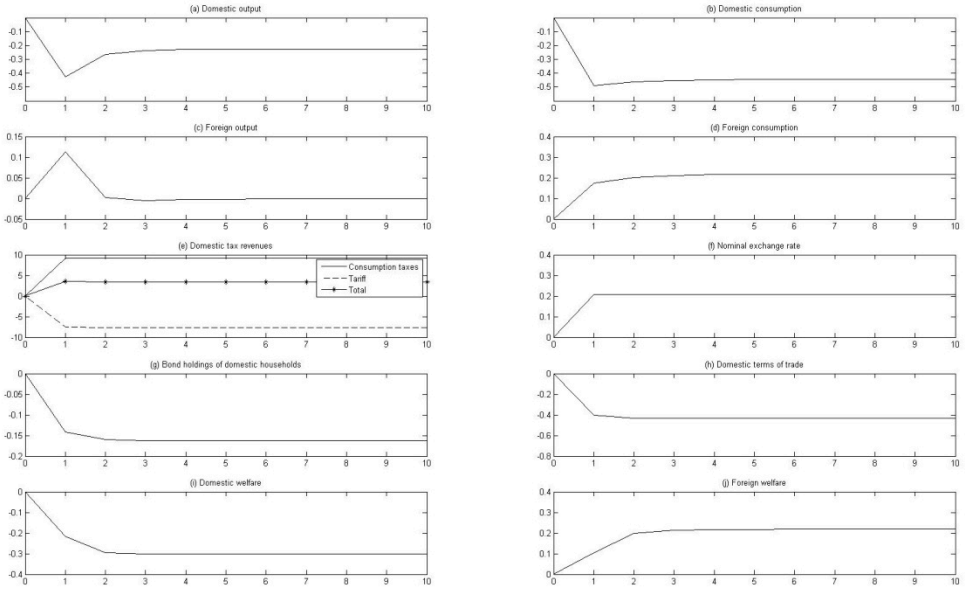


Table 5. Impact of a domestic tariff-tax reform on the DPV of domestic, foreign and world utility at different time horizons

dU_1	dU_1^*	dU_1^W	dU_{20}	dU_{20}^*	dU_{20}^W	dU_{DPV}	dU_{DPV}^*	dU_{DPV}^W
-0.22	0.10	-0.057	-0.30	0.22	-0.042	-30	22	-4.2

VI. CONCLUSIONS

This paper studies the impact of tariff-tax reforms in a two-country model with imperfect competition and nominal rigidities. In particular, we investigate the effects of a revenue-neutral reform in which the loss in revenue from tariff reductions is compensated by an increase in consumption taxes. This policy increases domestic output but reduces domestic welfare while increasing foreign and global welfare. This result is strongly driven by a terms of trade channel, namely the fact that reductions in tariffs worsen the terms of trade. This suggests that if developing countries approaching trade negotiations in a coordinated way as a bloc, they would be less willing to go ahead with trade liberalization. We also look at a point-for-point reform in which the consumption tax rate is increased by more than needed to

compensate for the revenue loss in tariff. In this case, not only domestic output and welfare but also global welfare falls.

One possible avenue for future research could be to extend the model to explicitly incorporate a game theoretic framework which would allow modeling the degree of coordination within each bloc of countries. Another interesting direction in which the model could be extended would be by explicitly modeling the idea that, for developing countries, the administrative costs of collecting consumption taxes might be higher than those related to trade taxes (see Mourmouras 1991).

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