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Abstract

This paper investigates the implications for the nominal exchange rate of a Border Tax Adjustment (BTA) when there is BTA neutrality. A border tax adjustment is a change from an origin-based system of taxation, that taxes exports but exempts imports to a destination-based system that taxes imports but exempts exports. Both indirect taxes (e.g. a VAT) and direct taxes (e.g. a cash-flow corporate profit tax) can be subject to a BTA. In the US, a BTA for the corporate profit tax is under discussion.

There is BTA neutrality when the real equilibrium, including measures of profitability and competitiveness, of an open economy is unchanged when it moves from an origin-based to a destination-based tax.

The conventional wisdom on the exchange rate implications of a neutral BTA is that the currency of the country implementing the BTA will strengthen (appreciate) by a percentage equal to the VAT or CPT tax rate. The main insight of this note is that this 'appreciation presumption' is not robust, even when all conditions for full BTA neutrality are satisfied. Indeed, plausible alternative assumptions about constancy (or stickiness) of nominal prices support a weakening (depreciation) of the currency by the same percentage as the tax rate. On the basis on the very patchy available empirical information, it is not possible to take a view with any degree of confidence on the implications of a BTA for the nominal exchange rate, even if full BTA neutrality prevailed. Whether BTA neutrality itself is a feature of the real world is also a disputed empirical issue. Therefore, buyer (or seller) beware.

Key words: Border tax adjustment; neutrality; equivalence; exchange rate appreciation; nominal price and wage rigidities.

JEL Classification: E31, E62, F11, F13, F41, H25, H87.

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(1) Introduction

This paper investigates the implications for the nominal exchange rate of a Border Tax Adjustment (BTA) when there is BTA neutrality. There is BTA neutrality when the real equilibrium, including measures of profitability and competitiveness, of an open economy is unchanged when it moves from an origin-based to a destination-based value added tax (VAT) or cash-flow based corporate profit tax (CPT).

The conventional wisdom on the exchange rate implications of a neutral BTA is that the currency of the country implementing the BTA will strengthen (appreciate) by a percentage equal to the VAT or CPT tax rate. The main insight of this note is that this 'appreciation presumption' is not robust, even when all conditions for full BTA neutrality are satisfied. Indeed a weakening (depreciation) of the currency of that same magnitude is also possible. On the basis on the incomplete empirical information that is available, it is no more likely that the conditions that support an appreciation are satisfied than that the conditions supporting a depreciation are satisfied. [2]

(1.1) BTA neutrality

In 1936, Abba P. Lerner wrote a remarkable paper (Lerner (1936)) that demonstrated the equivalence of a given proportional tariff on imports and an equal proportional tax on exports.[3] Both discourage trade. When trade is balanced (in a single-period model) or trade is balanced intertemporally in a multi-period model (the present discounted value (PDV) of current and future taxes equals the PDV of current and future imports plus the net foreign debt of the country), they both discourage trade equally. The same configuration of quantities and relative prices supports the same reduction in trade: their impact on the real economy, including measures of real competitiveness, is the same.

Under origin-based taxation imports are exempted from the VAT and excluded from the CPT base while exports are subject to the VAT and included in the CPT base. Under destination-based taxation, VAT is imposed on imports and imports are part of the CPT base while exports are exempted from the VAT and export revenues are not part of the CPT base. In the US, a change from an origin-based CPT that does not allow the immediate full expensing of capital expenditure to a destination-based cash flow CPT (one that does in addition allow immediate full capital expenditure expensing), is under consideration.(see Ways and Means Committee (2016)).

The Lerner "symmetry "or "equivalence" result has important implications for the effects on the real economy of border tax adjustments: Lerner "symmetry" implies BTA neutrality. According to Lerner's symmetry theorem, a given proportional tariff on (or subsidy to) imports is equivalent to an equal proportional tax on exports. The same logic implies that a given proportional subsidy on imports (or

[2] There is a little verbal sloppiness here which, however, saves a lot of additional words or notation. Strictly speaking, if the tax rate is θ, in the case where the currency depreciates, the domestic currency price of foreign exchange changes by a percentage equal to $100*\theta$. In the case where the currency appreciates, the domestic currency price of foreign exchange changes by a percentage equal to $-100*\theta/(1+\theta)$. So, with a 20% corporate profit tax rate, in the depreciation case the domestic currency price of foreign currency rises by 20% under BTA neutrality. In the appreciation case, the domestic currency price of foreign currency falls by 16.7%.

[3] The conditions for with Lerner proved the 'symmetry' result included competitive markets, constant returns to scale and balanced trade. It generalizes to imperfectly competitive markets also (see Ray (1975)) and to intertemporally balanced trade (Feldstein and Krugman (1990)).

reduction in tariffs or taxes on imports) is equivalent to an equal proportional subsidy (or reduction of taxes) on exports. A given proportional tariff on imports and an equal proportional subsidy (or cut in taxes) on imports obviously cancel each other out: there is no effect on anything. But since a given proportional subsidy to imports (or cut in tariff or cut in taxes on imports) is equivalent to the same proportional subsidy to exports (or cut in taxes on exports), it follows that a given proportional tariff on imports (or cut in subsidies or increase in taxes on imports) and an equal proportional subsidy to exports (or removal of an equal proportional tax on exports) also cancel each other out. A BTA that moves an economy from an origin-based to a destination-based system of taxation does not change competitiveness, import and export volumes or sectoral profitability, at home or abroad. This is the neutrality or equivalence proposition for BTAs. Some of the classic references on the subject are Shibata (1967), Mussa (1976), Whalley (1979), Razin (1983), Feldstein and Krugman (1990), De Meza et. al. (1994), Hufbauer and Gabyzon (1996) and Keen and Lahiri (1998). There have been recent applications of BTA neutrality proposals for taxing imports or exports for their carbon content (Lockwood and Whalley (2010) and to proposals for a VAT in the US (see Nicholson (2010)).

In this note I look at the (nominal) exchange rate implications of the neutrality proposition for BTAs, both for the case of a VAT and for the case of a cash flow CPT. The analysis for the cash flow CPT is the same as for the VAT, because of the well-known proposition, (see e.g. Mirrlees Committee (2011) and Auerbach et. al. (2017)), briefly confirmed below, that the introduction of a broad-based uniform rate cash flow CPT is equivalent to the introduction of a broad-based, uniform rate VAT at that same uniform rate, together with a reduction in payroll tax rates by that same rate.[4]

(1.2) BTA neutrality and the nominal exchange rate

The formal theory of BTA is for barter economies – all propositions involve real quantities and relative prices only. In Section 2, I show that the (highly intuitive) implications of BTA neutrality for two key real competitiveness measures are the following:

(1) The *tax-inclusive* (gross-of-tax) relative price of imports to exports *rises* by a percentage equal to the tax rate.

(2) The *tax-exclusive* (net-of-tax) relative price of imports to exports *falls* by a percentage equal to the tax rate. [5]

BTA neutrality has no implications for the nominal exchange rate. Despite this, there is a widespread belief, expressed mostly in media interviews, op-eds and other non-technical writings, that BTA neutrality is achieved through an appreciation of the nominal exchange rate of the country implementing the BTA, by a percentage equal to the tax rate. Examples include Auerbach and Holtz–

[4] Strictly speaking, the equivalence of a given percentage rate destination-based cash flow CPT and the same percentage rate destination-based VAT requires that in the VAT case there be a cut in the tax on all domestically sourced inputs into production by that same percentage rate. Not only the payroll tax should be cut, but also taxes on rents and other domestic costs, including interest etc.

[5] As in footnote 1, strictly speaking, if the tax rate is θ, the tax-inclusive relative price of imports to exports changes (rises) by a percentage equal to $100*\theta$ and the tax-exclusive relative price of imports to exports changes (falls) by a percentage equal to $-100*\frac{\theta}{1+\theta}$.

Eakin (2016), Worstall (2017), Feldstein (2017), Irwin (2017), Krugman (2017), Davies (2017), Greenberg and Hodge (2017), Setzer (2017), Summers (2017) and, as part of an earlier debate on VAT, Mankiw (2010). According to this conventional wisdom, if the USA were to (1) cut the current corporate tax rate (in the current origin-based US system of corporate taxation) from 35% to 20%, (2) change to a cash flow tax (by making capital expenditure fully deductible when the expenditure takes place) and (3) move to a destination-based cash flow corporate profit tax, the third step (the BTA) would strengthen the external value of the US dollar by 20%. This has created a lot of interest in BTAs even among those who are not engaged in cross-border trade in real goods and services. Those engaged in cross-border financial investment are clearly interested in the possibility of a 20% appreciation of the US dollar, how much of this potential future dollar appreciation is already 'priced in' etc.. This paper is intended to challenge the conventional wisdom about the response of the US dollar to a BTA in the US.

To get from the real implications of BTA neutrality – including the two just-stated propositions about the terms of trade – to the implications of BTA neutrality for the nominal exchange rate, we need assumptions about the constancy of certain nominal prices. Constancy of nominal prices can be interpreted, by those of a Keynesian persuasion, as (short-run) nominal rigidity or stickiness of nominal prices. Alternatively, it can also be interpreted, by those of a New Classical persuasion, as nominal constancy through appropriate domestic and foreign monetary and exchange rate policies, despite complete nominal price flexibility. In what follows, I choose the Keynesian characterization, which has the expositional advantage of making it unnecessary to characterize a complete global monetary economy plus the domestic and foreign monetary and exchange rate policies supporting alternative nominal price constancy assumptions.

In an open economy with two currencies and with taxes, constancy of nominal prices has two dimensions: (1) the currency in terms of which prices are constant (home currency (the US dollar in what follows), or foreign currency (the euro in what follows) and (2) whether it is tax-inclusive or tax-exclusive prices that are constant in nominal terms. If US export prices are constant in dollar terms, we shall refer to this as *origin currency pricing*. If US import prices are constant in euro, this too is would be origin currency pricing. US export prices constant in euro will be called *destination currency pricing* or *pricing-to-market*. So would US import prices constant in dollars.

There are sixteen constant nominal price combinations to consider, as shown in Table 1 below. Table 1 also contains the implications of the various constant nominal price assumptions for the nominal dollar exchange rate – anticipating the derivation of these results in Section 3 below. In Table 1, *M* stands for imports, *X* for exports and *e* for the nominal dollar exchange rate (number of dollars per euro). A fall in *e* is an appreciation (strengthening) of the dollar and an increase in *e* a depreciation (weakening) of the dollar in terms of the euro.

Table 1

Nominal dollar exchange rate response to BTA under neutrality

	X in $ Net of tax	*X* in $ Tax-inclusive	*X* in € Net of Tax	*X* in € Tax-inclusive
M in € Net of tax	***A***	***C***	***X***	***I***
M in € Tax-inclusive	***C***	***D***	***I***	***X***
M in $ Net of tax	***X***	***I***	***D***	***C***
M in $ Tax-inclusive	***I***	***X***	***C***	***A***
A**:** appreciation; $\text{percentage change} = 100*(\underline{e} - \overline{e})/\overline{e} = -100*\theta/(1+\theta)$				
D: depreciation; $\text{percentage change} = 100*(\underline{e} - \overline{e})/\overline{e} = 100*\theta$				
C**:** constant				
I**:** indeterminate				
X*:* inconsistent with BTA neutrality				
$\overline{e}$ **:** value of exchange rate in origin regime; $\underline{e}$ value of exchange rate in destination regime				

Of the 16 possible nominal price constancy configurations two produce a dollar appreciation and two a dollar depreciation; four support a constant exchange rate; four generate indeterminacy of the nominal exchange rate; and four are inconsistent with BTA neutrality.

Fortunately, it is only necessary to consider four cases in greater detail. The four indeterminate nominal exchange rate outcomes and the four that are incompatible with BTA neutrality are of no interest. The four constant nominal exchange rate outcomes all have the undesirable characteristic that the nominal price constancy assumptions that support them either have import prices constant *net-of-tax* but export prices constant *including tax,* or import prices constant *including tax* but *export prices* constant *net-of-tax*. This asymmetry is not easily rationalized and I will not consider the four constant nominal exchange rate outcomes in detail for that reason. I will therefore only discuss in detail, in Section 4, the two nominal price constancy assumptions supporting a currency appreciation and the two nominal price constancy assumptions supporting a currency depreciation.

(2) The Model

I will not provide a proof of the or of the neutrality proposition for BTAs, or even a complete model of a two-country global economy with trade, because that has been done many times already, notably in the classic paper by Feldstein and Krugman (1990). Instead I will provided expressions for a key economic relationship - real after-tax corporate profits- and for a number for key relative prices faced by households and corporations at home (in the US) and abroad (in the Eurozone) – relative prices whose constancy is a necessary condition for BTA neutrality. Making alternative assumptions about nominal price constancy, I then assume that the real neutrality proposition for BTAs holds, which then allows me to back out the implications of a neutral BTA for the US dollar exchange rate vis-à-vis the euro.

The focus of the paper is on BTAs rather than on cash flow corporate profit taxes. I therefore simplify the analysis by leaving out capital goods and capital expenditure.

Formally, I will do the following:

(1) Provide an equation for the after-tax profits of a representative US firm that produces for the domestic market ('domestic goods' henceforth), imports goods, exports goods to the Eurozone, uses domestic inputs (limited to labor for sake of brevity) and pays its taxes.
(2) Provide an equation for tax revenues under the origin-based tax and under the destination-based tax.
(3) Specify the relative price of imports and domestic goods faced by US households, the real consumption wage (the real wage relevant to households/consumers/workers), the relative price of imports and domestic goods faced by US firms, the relative price of exports and domestic goods faced by US firms and the real product wages faced by US firms in the domestic and export sectors, the relative price of US exports to Eurozone domestic goods in the Eurozone and the relative price of Eurozone exports (US imports) to Eurozone domestic goods in the Eurozone, Eurozone real product wages in the Eurozone domestic and export sectors and the Eurozone real consumption wage.
(4) Assume that the tax rate on domestic goods produced for the domestic market is constant and that all foreign tax rates are kept constant – a unilateral BTA without foreign response.
(5) Show that a key implication of real BTA neutrality is an increase in the tax-inclusive relative price of imports to exports by a percentage equal to the tax rate and a fall in the net-of-tax relative price of imports to exports by that same percentage. This is consistent with (indeed required by) constant real corporate profits will be constant; it is also consistent with all relative prices faced by households and firms being the same as before the BTA. Tax revenues in the current period will go up if there is a trade deficit, down if there is a trade surplus.

Notation

P_d : price of US domestically produced good sold domestically, inclusive of tax (in US$).

P_x : price of US exports, inclusive of tax (in US$)

P_x^* : price of US exports, exclusive of tax (in euro)

P_m^* : price of US imports, exclusive of tax (in euro)

P_m : price of US imports, inclusive of tax (in US$)

$P_{d^*}^*$: price of foreign goods produced and sold in the foreign country, inclusive of foreign tax (in euro)

w : US money wage (in US$)

w^* : foreign money wage (in euro)

e : nominal US$-euro exchange rate (number of US$ per euro)

Q_d : quantity of domestically produced goods sold domestically

X : quantity of US exports

M : quantity of US imports

L_d : employment in production for the US domestic market

L_x : employment in the US export sector

θ : US value added tax rate or corporate profit tax rate (as a percentage of the tax-exclusive price)

Π : US corporate profits after tax (in US$)

T : US tax paid/tax revenue (in US$)

A variable with a single overbar refers to the value of this variable under an origin-based tax.

A variable with a single underbar refers to the value of this variable under a destination-based tax.

The home country is the US and the home currency the dollar; the foreign country is the Eurozone and the foreign currency the euro.

2.1 The VAT case

Note that P_m is the dollar market price of imports paid by US consumers. It includes the VAT when this is levied on imports (in the destination regime); P_m^* is the foreign currency price of imports, excluding VAT; P_x is the dollar market price received by US exporters. It includes the VAT when this is levied on exports (in the origin regime); P_x^* is the foreign currency price of exports, excluding VAT. It follows that:

$$
\begin{aligned}
\bar{P}_m &= \bar{e}\bar{P}_m^* \\
\bar{P}_x &= (1+\theta)\bar{e}\bar{P}_x^* \\
\underline{\bar{P}}_m &= (1+\theta)\underline{\bar{e}}\,\underline{\bar{P}}_m^* \\
\underline{\bar{P}}_x &= \underline{\bar{e}}\,\underline{\bar{P}}_x^*
\end{aligned}
\tag{1}
$$

2.1a The origin-based VAT

With an origin-based VAT, exports are taxed, but imports are not. The representative US firm produces goods for the domestic market (US domestic goods) and for exports, using imported goods and a single type of labor as inputs. US domestic goods could be, but need not be, non-traded goods. The model is easily generalized, by considering a vector of goods produced for the domestic market, to the case where there are non-traded goods, but goods identical to exports can be sold in the domestic market and goods identical to imports can be produced domestically. After-tax profits and tax revues can be written as follows:

$$
\begin{aligned}
\bar{\Pi} &= \frac{\bar{P}_d}{1+\theta}\bar{Q}_d + \frac{\bar{P}_x}{1+\theta}\bar{X} - \bar{e}\bar{P}_m^*\bar{M} - \bar{w}(\bar{L}_d + \bar{L}_x) \\
\bar{T} &= \frac{\theta}{1+\theta}\left(\bar{P}_d\bar{Q}_d + \bar{P}_x\bar{X}\right)
\end{aligned}
\tag{2}
$$

Domestic buyers (consumers/households/workers) face the following relative price of imports and domestic products in the origin regime (where imports are not taxed):

$$
\bar{R}_m^h = \frac{\bar{P}_m}{\bar{P}_d} = \frac{\bar{e}\bar{P}_m^*}{\bar{P}_d}
\tag{3}
$$

I assume domestic consumers face a real consumption wage given by the nominal consumption wage deflated by a Cobb-Douglas price index of domestic goods and imports:

$$
\bar{R}_l^h = \frac{\bar{w}}{\bar{P}_d^{\alpha}\bar{P}_m^{1-\alpha}}, \quad 0<\alpha<1
\tag{4}
$$

US producers (or firms) care about a relative price of imports to domestic goods that differs from that of US households, because producers only receive the after-tax price of domestic goods. So for producers the relevant relative price of imports to domestic goods is:

$$
\bar{R}_m^f = \frac{\bar{P}_m}{\bar{P}_d/(1+\theta)} = \frac{\bar{e}\bar{P}_m^*}{\bar{P}_d/(1+\theta)}
\tag{5}
$$

The relative price of exports to US domestic goods or imports is irrelevant to US consumers, as they don't consume exports. For US producers, the relative price of exports (which are taxed under the origin regime) is:

$$
\bar{R}_x^f = \frac{\bar{P}_x/(1+\theta)}{\bar{P}_d/(1+\theta)} = \frac{\bar{P}_x}{\bar{P}_d} = (1+\theta)\frac{\bar{e}\bar{P}_x^*}{\bar{P}_d}
\tag{6}
$$

The US producer's real product wage in the domestic sector is given by:

$$\bar{R}^{f}_{w,d} = \frac{\bar{w}}{\bar{P}_d / (1+\theta)} \tag{7}$$

The US producer's real product wage in the export sector is given by:

$$\bar{R}^{f}_{w,x} = \frac{\bar{w}}{\bar{P}_x / (1+\theta)} \tag{8}$$

The Eurozone exporter to the US faces a relative price of his exports (US imports) to Eurozone goods produced and sold in the Eurozone given by:

$$\bar{R}^{*f}_{m} = \frac{\bar{P}^{*}_{m}}{\bar{P}^{*}_{d}} \tag{9}$$

Remember that all foreign (Eurozone) taxes are assumed constant when the US BTA occurs, so without loss of generality I set all Eurozone tax rates equal to zero.

The Eurozone producer for the Eurozone market faces the following relative price of US exports (Eurozone imports) to Eurozone goods produced for the Eurozone market:

$$\bar{R}^{*f}_{x} = \frac{(1+\theta)\bar{P}^{*}_{x}}{\bar{P}^{*}_{d}} \tag{10}$$

Eurozone households/consumers/workers face a real consumption wage given by the nominal consumption wage deflated by a Cobb-Douglas price index of domestic goods and imports:

$$\bar{R}^{*h}_{l} = \frac{\bar{w}^{*}}{\left(\bar{P}^{*}_{d}\right)^{\alpha^{*}} \left(\bar{P}^{*}_{m}\right)^{1-\alpha^{*}}}, \quad 0 < \alpha^{*} < 1 \tag{11}$$

The Eurozone producer's real product wage in the Eurozone domestic sector is given by:

$$\bar{R}^{*f}_{w^{*},d} = \frac{\bar{w}^{*}}{\bar{P}^{*}_{d}} \tag{12}$$

The Eurozone producer's real product wage in the Eurozone export sector is given by:

$$\bar{R}^{*f}_{w^{*},x} = \frac{\bar{w}^{*}}{\bar{P}^{*}_{m}} \tag{13}$$

2.1b The destination-based VAT

In the destination-based VAT regime, with US domestic value added and US imports taxed but US exports not taxed, after-tax revenues can be written as follows:

$$\underline{\Pi} = \frac{\underline{P}_d}{1+\theta}\underline{Q}_d + \underline{P}_x\underline{X} - (1+\theta)\underline{e}\underline{P}_m^*\underline{M} - \underline{w}(\underline{L}_d + \underline{L}_x)$$
$$\underline{T} = \frac{\theta}{1+\theta}\left[\underline{P}_d\underline{Q}_d + (1+\theta)\underline{e}\underline{P}_m^*\underline{M}\right] \tag{14}$$

US consumers now face the following relative price of imports and domestic products:

$$\underline{R}_m^h = \frac{\underline{P}_m}{\underline{P}_d} = \frac{(1+\theta)\underline{e}\underline{P}_m^*}{\underline{P}_d} \tag{15}$$

The household's real consumption wage is:

$$\underline{R}_l^h = \frac{\underline{w}}{\underline{P}_d^{\alpha}\underline{P}_m^{1-\alpha}} \tag{16}$$

The relative price of US imports to US domestic goods for US producers and the relative price of US exports to US domestic goods for US producers in the destination regime are given by:

$$\underline{R}_m^f = \frac{\underline{P}_m}{\underline{P}_d/(1+\theta)} = \frac{(1+\theta)\underline{e}\underline{P}_m^*}{\underline{P}_d/(1+\theta)} \tag{17}$$

and

$$\underline{R}_x^f = \frac{\underline{P}_x}{\underline{P}_d/(1+\theta)} = \frac{\underline{e}\underline{P}_x^*}{\underline{P}_d/(1+\theta)} \tag{18}$$

The US producer's real product wage in the domestic sector is given by:

$$\underline{R}_{w,d}^f = \frac{\underline{w}}{\underline{P}_d/(1+\theta)} \tag{19}$$

The US producer's real product wage in the US export sector is given by:

$$\underline{R}_{w,x}^f = \frac{\underline{w}}{\underline{e}\underline{P}_x^*} \tag{20}$$

The Eurozone exporter to the US receives a relative price for his goods vis-à-vis Eurozone goods produced and sold in the Eurozone given by:

$$\underline{R}_m^{*f} = \frac{\underline{P}_m^*}{\underline{P}_{d^*}^*} \tag{21}$$

The Eurozone producer for the Eurozone market faces the following relative price of US exports (Eurozone imports) to Eurozone goods produced for the Eurozone market:

$$\underline{R}_x^{*f} = \frac{\underline{P}_x^*}{\underline{P}_{d^*}^*} \tag{22}$$

Eurozone consumers face a real consumption wage given by the nominal consumption wage deflated by a Cobb-Douglas price index of domestic goods and imports:

$$\underline{R}_l^{*h} = \frac{\underline{w}^*}{\left(\underline{P}_{d^*}^*\right)^{a^*}\left(\underline{P}_m^*\right)^{1-\alpha^*}}, \quad 0<\alpha^*<1 \tag{23}$$

The Eurozone producer's real product wage in the Eurozone domestic sector is given by:

$$\underline{R}_{w^*,d^*}^{*f} = \frac{\underline{w}^*}{\underline{P}_d^*} \tag{24}$$

The Eurozone producer's real product wage in the Eurozone export sector is given by:

$$\underline{R}_{w^*,x}^{*f} = \frac{\underline{w}^*}{\underline{P}_m^*} \tag{25}$$

2.1c Potential differences between the destination and origin regimes

The differences between after tax profits (in dollars), tax revenues (in dollars) and the various relative prices in the destination and origin regimes are:

$$\begin{aligned}\underline{\Pi}-\bar{\Pi} &= \frac{1}{1+\theta}\left(\underline{P}_d\underline{Q}_d-\bar{P}_d\bar{Q}_d\right)+\underline{P}_x\underline{X}-\frac{1}{1+\theta}\bar{P}_x\bar{X}-\left((1+\theta)\underline{e}\underline{P}_m^*\underline{M}-\bar{e}\bar{P}_m^*\bar{M}\right)\\ &\quad-\left(\underline{w}\underline{L}_d-\bar{w}\bar{L}_d+\underline{w}\underline{L}_x-\bar{w}\bar{L}_x\right)\Big)\\ \underline{T}-\bar{T} &= \frac{\theta}{1+\theta}\left(\underline{P}_d\underline{Q}_d-\bar{P}_d\bar{Q}_d+(1+\theta)\underline{e}\underline{P}_m^*\underline{M}-\bar{P}_x\bar{X}\right)\end{aligned}$$

It is more informative to look at the difference in *real* after-tax profits and in *real* tax revenues. We obtain the 'real' values by deflating the dollar values by the dollar price of domestic goods (inclusive of VAT; since the VAT rate on domestic goods does not change between the origin and the destination regimes, the same results would be obtained by deflating by the net-of-tax price of domestic goods):

$$\begin{aligned}\frac{\underline{\Pi}}{\underline{P}_d}-\frac{\bar{\Pi}}{\bar{P}_d} &= \frac{1}{1+\theta}\left(\underline{Q}_d-\bar{Q}_d\right)+\frac{\underline{P}_x}{\underline{P}_d}\underline{X}-\left(\frac{1}{1+\theta}\right)\frac{\bar{P}_x}{\bar{P}_d}\bar{X}-\left(\frac{(1+\theta)\underline{e}\underline{P}_m^*}{\underline{P}_d}\underline{M}-\frac{\bar{e}\bar{P}_m^*}{\bar{P}_d}\bar{M}\right)\\ &\quad-\left(\frac{\underline{w}}{\underline{P}_d}\underline{L}_d-\frac{\bar{w}}{\bar{P}_d}\bar{L}_d+\frac{\underline{w}}{\underline{P}_d}\underline{L}_x-\frac{\bar{w}}{\bar{P}_d}\bar{L}_x\right)\end{aligned} \tag{26}$$

$$\frac{\underline{T}}{\underline{P}_d}-\frac{\bar{T}}{\bar{P}_d} = \frac{\theta}{1+\theta}\left(\underline{Q}_d-\bar{Q}_d+\frac{(1+\theta)\underline{e}\underline{P}_m^*}{\underline{P}_d}\underline{M}-\frac{\bar{P}_x}{\bar{P}_d}\bar{X}\right) \tag{27}$$

$$
\begin{aligned}
\underline{R}_m^f - \bar{R}_m^f &= \frac{\underline{P}_m}{\underline{P}_d/(1+\theta)} - \frac{\bar{P}_m}{\bar{P}_d/(1+\theta)} = \frac{(1+\theta)\underline{e}\underline{P}_m^*}{\underline{P}_d/(1+\theta)} - \frac{\bar{e}\bar{P}_m^*}{\bar{P}_d/(1+\theta)} \\
\underline{R}_x^f - \bar{R}_x^f &= \frac{\underline{P}_x}{\underline{P}_d/(1+\theta)} - \frac{\bar{P}_x}{\bar{P}_d} = \frac{\underline{e}\underline{P}_x^*}{\underline{P}_d/(1+\theta)} - \frac{(1+\theta)\bar{e}\bar{P}_x^*}{\bar{P}_d} \\
\underline{R}_m^h - \bar{R}_m^h &= \frac{\underline{P}_m}{\underline{P}_d} - \frac{\bar{P}_m}{\bar{P}_d} = \frac{(1+\theta)\underline{e}\underline{P}_m^*}{\underline{P}_d} - \frac{\bar{e}\bar{P}_m^*}{\bar{P}_d} \\
\underline{R}_l^h - \bar{R}_l^h &= \frac{\underline{w}}{\underline{P}_d^{\alpha}\underline{P}_m^{1-\alpha}} - \frac{\bar{w}}{\bar{P}_d^{\alpha}\bar{P}_m^{1-\alpha}} \\
\underline{R}_{w,d}^f - \bar{R}_{w,d}^f &= \frac{\underline{w}}{\underline{P}_d/(1+\theta)} - \frac{\bar{w}}{\bar{P}_d/(1+\theta)} \\
\underline{R}_{w,x}^f - \bar{R}_{w,x}^f &= \frac{\underline{w}}{\underline{e}\underline{P}_x^*} - \frac{\bar{w}}{\bar{P}_x/(1+\theta)} \\
\underline{R}_m^{*f} - \bar{R}_m^{*f} &= \frac{\underline{P}_m^*}{\underline{P}_{d^*}^*} - \frac{\bar{P}_m^*}{\bar{P}_{d^*}^*} \\
\underline{R}_x^{*f} - \bar{R}_x^{*f} &= \frac{\underline{P}_x^*}{\underline{P}_{d^*}^*} - \frac{(1+\theta)\bar{P}_x^*}{\bar{P}_{d^*}^*} \\
\underline{R}_l^{*h} - \bar{R}_l^{*h} &= \frac{\underline{w}^*}{\left(\underline{P}_{d^*}^*\right)^{\alpha^*}\left(\underline{P}_m^*\right)^{1-\alpha^*}} - \frac{\bar{w}^*}{\left(\bar{P}_{d^*}^*\right)^{\alpha^*}\left(\bar{P}_m^*\right)^{1-\alpha^*}} \\
\underline{R}_{w^*,d^*}^{*f} - \bar{R}_{w^*,d^*}^{*f} &= \frac{\underline{w}^*}{\underline{P}_{d^*}^*} - \frac{\bar{w}^*}{\bar{P}_{d^*}^*} \\
\underline{R}_{w^*,m}^{*f} - \bar{R}_{w^*,m}^{*f} &= \frac{\underline{w}^*}{\underline{P}_m^*} - \frac{\bar{w}^*}{\bar{P}_m^*}
\end{aligned}
\tag{28}
$$

2.1d BTA neutrality in the domestic economy

When will real after-tax profits be the same in the origin and the destination regime (both in the aggregate and severally in the production of goods for the domestic market, for exports and for imports? The conditions are:

$$
\begin{aligned}
&\underline{Q}_d = \bar{Q}_d \\
&\underline{M} = \bar{M} \text{ and } \frac{\underline{P}_m}{\underline{P}_d} = \frac{\bar{P}_m}{\bar{P}_d} \text{ or } \frac{\underline{e}\underline{P}_m^*}{\underline{P}_d} = \left(\frac{1}{1+\theta}\right)\frac{\bar{e}\bar{P}_m^*}{\bar{P}_d} \\
&\underline{X} = \bar{X} \text{ and } \frac{\underline{P}_x}{\underline{P}_d} = \left(\frac{1}{1+\theta}\right)\frac{\bar{P}_x}{\bar{P}_d} \text{ or } \frac{\underline{e}\underline{P}_x^*}{\underline{P}_d} = \frac{\bar{e}\bar{P}_x^*}{\bar{P}_d} \\
&\underline{L}_d = \bar{L}_d,\ \underline{L}_x = \bar{L}_x \text{ and } \frac{\underline{w}}{\underline{P}_d} = \frac{\bar{w}}{\bar{P}_d}
\end{aligned}
\tag{29}
$$

$$\underline{R}_m^h = \bar{R}_m^h \text{ so } \frac{\underline{P}_m}{\underline{P}_d} = \frac{\bar{P}_m}{\bar{P}_d} \text{ and } \frac{\underline{e}\underline{P}_m^*}{\underline{P}_d} = \left(\frac{1}{1+\theta}\right)\frac{\bar{e}\bar{P}_m^*}{\bar{P}_d}$$

$$\underline{R}_m^f = \bar{R}_m^f \text{ so } \frac{\underline{P}_m}{\underline{P}_d} = \frac{\bar{P}_m}{\bar{P}_d} \text{ and } \frac{\underline{e}\underline{P}_m^*}{\underline{P}_d} = \left(\frac{1}{1+\theta}\right)\frac{\bar{e}\bar{P}_m^*}{\bar{P}_d}$$

$$\underline{R}_x^f = \bar{R}_x^f \text{ so } \frac{\underline{P}_x}{\underline{P}_d} = \left(\frac{1}{1+\theta}\right)\frac{\bar{P}_x}{\bar{P}_d} \text{ and } \frac{\underline{e}\underline{P}_x^*}{\underline{P}_d} = \frac{\bar{e}\bar{P}_x^*}{\bar{P}_d}$$

$$\underline{R}_l^h = \bar{R}_l^h \text{ so } \frac{\underline{w}}{\underline{P}_d^{\alpha}\underline{P}_m^{1-\alpha}} = \frac{\bar{w}}{\bar{P}_d^{\alpha}\bar{P}_m^{1-\alpha}} \text{ and } \frac{\underline{w}}{\underline{P}_d^{\alpha}\left((1+\theta)\underline{e}\underline{P}_m^*\right)^{1-\alpha}} = \frac{\bar{w}}{\bar{P}_d^{\alpha}\left(\bar{e}\bar{P}_m^*\right)^{1-\alpha}}$$

$$\underline{R}_{w,d}^f = \bar{R}_{w,d}^f \text{ so } \frac{\underline{w}}{\underline{P}_d} = \frac{\bar{w}}{\bar{P}_d}$$

$$\underline{R}_{w,x}^f = \bar{R}_{w,x}^f \text{ so } \frac{\underline{w}}{\underline{P}_x} = \frac{\bar{w}}{\bar{P}_x/(1+\theta)} \text{ and } \frac{\underline{w}}{\underline{e}\underline{P}_x^*} = \frac{\bar{w}}{\bar{e}\bar{P}_x^*}$$

$$\underline{R}_m^{*f} = \bar{R}_m^{*f} \text{ so } \frac{\underline{P}_m^*}{\underline{P}_d^*} = \frac{\bar{P}_m^*}{\bar{P}_d^*}$$

$$\underline{R}_x^{*f} = \bar{R}_x^{*f} \text{ so } \frac{\underline{P}_x^*}{\underline{P}_d^*} = \frac{(1+\theta)\bar{P}_x^*}{\bar{P}_d^*}$$

$$\underline{R}_m^{*f} = \frac{\underline{P}_m^*(1+\theta)}{\underline{P}_d^*}$$

$$\underline{R}_m^{*f} = \bar{R}_m^{*f} \text{ so } \frac{\underline{P}_m^*}{\underline{P}_{d^*}^*} = \frac{\bar{P}_m^*}{\bar{P}_{d^*}^*}$$

$$\underline{R}_x^{*f} = \bar{R}_x^{*f} \text{ so } \frac{\underline{P}_x^*}{\underline{P}_{d^*}^*} = \frac{(1+\theta)\bar{P}_x^*}{\bar{P}_{d^*}^*}$$

$$\underline{R}_l^{*h} = \bar{R}_l^{*h} \text{ so } \frac{\underline{w}^*}{\left(\underline{P}_{d^*}^*\right)^{a^*}\left(\underline{P}_m^*\right)^{1-\alpha^*}} = \frac{\bar{w}^*}{\left(\bar{P}_{d^*}^*\right)^{a^*}\left(\bar{P}_m^*\right)^{1-\alpha^*}}$$

$$\underline{R}_{w^*,d^*}^{*f} = \bar{R}_{w^*,d^*}^{*f} \text{ so } \frac{\underline{w}^*}{\underline{P}_{d^*}^*} - \frac{\bar{w}^*}{\bar{P}_{d^*}^*}$$

$$\underline{R}_{w^*,m}^{*f} = \bar{R}_{w^*,m}^{*f} \text{ so } \frac{\underline{w}^*}{\underline{P}_m^*} - \frac{\bar{w}^*}{\bar{P}_m^*} \tag{30}$$

When there is BTA neutrality, the difference in real tax receipts between the two regimes is given by:

$$\frac{\underline{T}}{\underline{P}_d} - \frac{\bar{T}}{\bar{P}_d} = \theta\left(\frac{\underline{e}\underline{P}_m^*}{\underline{P}_d}\underline{M} - \frac{\underline{P}_x}{\underline{P}_d}\underline{X}\right) = \frac{\theta}{1+\theta}\left(\frac{\underline{P}_m}{\underline{P}_d}\underline{M} - \frac{(1+\theta)\underline{P}_x}{\underline{P}_d}\underline{X}\right) \tag{31}$$

When will (single-period) real tax revenues be the same in the origin and the destination regime? The condition for single-period real tax revenue neutrality is balanced trade:

$$\frac{(1+\theta)\underline{e}\underline{P}_m^*}{\underline{P}_d}\underline{M} = \frac{\bar{P}_x}{\bar{P}_d}\bar{X} \tag{32}$$

2.2 The Corporate Profit Tax Case

The CPT rate is θ.

2.2a The origin-based CPT

With an origin-based CPT, exports are taxed, but imports are not. After-tax profits and tax revenues can be written as follows:

$$\begin{aligned}\bar{\Pi} &= \frac{\bar{P}_d}{1+\theta}\bar{Q}_d + \frac{\bar{P}_x}{1+\theta}\bar{X} - \bar{e}\bar{P}_m^*\bar{M} - (1-\theta)\bar{w}(\bar{L}_d + \bar{L}_x) \\ \bar{T} &= \frac{\theta}{1+\theta}\left(\bar{P}_d\bar{Q}_d + \bar{P}_x\bar{X} + \right) - \theta\bar{w}(\bar{L}_d + \bar{L}_x)\end{aligned} \tag{33}$$

The only difference between VAT after-tax profits in equation (2) and CPT after-tax corporate profits is that the CPT does not tax the US payroll.

Of the eleven relative prices considered for the VAT case, I will only provide those that are different in the CPT case.

The US producer's real product wage in the domestic sector is given by:

$$\bar{R}_{w,d}^f = \frac{(1-\theta)\bar{w}}{\bar{P}_d/(1+\theta)}$$

The US producer's real product wage in the export sector is given by:

$$\bar{R}_{w,x}^f = \frac{(1-\theta)\bar{w}}{\bar{P}_x/(1+\theta)}$$

2.2b The destination-based CPT

In the destination-based VAT regime, with domestic value added and imports taxed but exports not taxed, after-tax revenues can be written as follows:

$$\begin{aligned}\underline{\Pi} &= \frac{\underline{P}_d}{1+\theta}\underline{Q}_d + \underline{P}_x\underline{X} - (1+\theta)\underline{e}\underline{P}_m^*\underline{M} - (1-\theta)\underline{w}(\underline{L}_d + \underline{L}_x) \\ \underline{T} &= \frac{\theta}{1+\theta}\left[\underline{P}_d\underline{Q}_d + (1+\theta)\underline{e}\underline{P}_m^*\underline{M}\right] - \theta\underline{w}(\underline{L}_d + \underline{L}_x)\end{aligned} \tag{34}$$

Again only the relative prices that differ from those in the VAT case are provided.

The US producer's real product wage in the domestic sector is given by:

$$\underline{R}^{f}_{w,d} = \frac{(1-\theta)\underline{w}}{\underline{P}_d / (1+\theta)}$$

The US producer's real product wage in the export sector is given by:

$$\underline{R}^{f}_{w,x} = \frac{(1-\theta)\underline{w}}{\underline{e}\underline{P}^{*}_{x}}$$

2.2c Potential differences between the destination and origin regimes in the CPT case

The differences between after tax profits (in dollars), tax revenues (in dollars) and the various relative or real prices in the destination and origin regimes are:

$$\begin{aligned}\underline{\Pi} - \bar{\Pi} &= \frac{1}{1+\theta}\left(\underline{P}_d\underline{Q}_d - \bar{P}_d\bar{Q}_d\right) + \underline{P}_x\underline{X} - \frac{1}{1+\theta}\bar{P}_x\bar{X} - \left((1+\theta)\,\underline{e}\underline{P}^{*}_{m}\underline{M} - \bar{e}\bar{P}^{*}_{m}\bar{M}\right) \\ &\quad -(1-\theta)\left(\underline{w}\underline{L}_d - \bar{w}\bar{L}_d + \underline{w}\underline{L}_x - \bar{w}\bar{L}_x\right)\Big) \\ \underline{T} - \bar{T} &= \frac{\theta}{1+\theta}\left(\underline{P}_d\underline{Q}_d - \bar{P}_d\bar{Q}_d + (1+\theta)\underline{e}\underline{P}^{*}_{m}\underline{M} - \bar{P}_x\bar{X}\right) - \theta\left(\underline{w}\underline{L}_d - \bar{w}\bar{L}_d + \underline{w}\underline{L}_x - \bar{w}\bar{L}_x\right)\Big)\end{aligned}$$

In real terms this becomes:

$$\begin{aligned}\frac{\underline{\Pi}}{\underline{P}_d} - \frac{\bar{\Pi}}{\bar{P}_d} &= \frac{1}{1+\theta}\left(\underline{Q}_d - \bar{Q}_d\right) + \frac{\underline{P}_x}{\underline{P}_d}\underline{X} - \left(\frac{1}{1+\theta}\right)\frac{\bar{P}_x}{\bar{P}_d}\bar{X} - \left(\frac{(1+\theta)\underline{e}\underline{P}^{*}_{m}}{\underline{P}_d}\underline{M} - \frac{\bar{e}\bar{P}^{*}_{m}}{\bar{P}_d}\bar{M}\right) \\ &\quad -(1-\theta)\left(\frac{\underline{w}}{\underline{P}_d}\underline{L}_d - \frac{\bar{w}}{\bar{P}_d}\bar{L}_d + \frac{\underline{w}}{\underline{P}_d}\underline{L}_x - \frac{\bar{w}}{\bar{P}_d}\bar{L}_x\right)\Big)\end{aligned} \tag{35}$$

$$\frac{\underline{T}}{\underline{P}_d} - \frac{\bar{T}}{\bar{P}_d} = \frac{\theta}{1+\theta}\left(\underline{Q}_d - \bar{Q}_d + \frac{(1+\theta)\underline{e}\underline{P}^{*}_{m}}{\underline{P}_d}\underline{M} - \frac{\bar{P}_x}{\bar{P}_d}\bar{X}\right) - \theta\left(\frac{\underline{w}}{\underline{P}_d}\underline{L}_d - \frac{\bar{w}}{\bar{P}_d}\bar{L}_d + \frac{\underline{w}}{\underline{P}_d}\underline{L}_x - \frac{\bar{w}}{\bar{P}_d}\bar{L}_x\right)\Big) \tag{36}$$

$$\begin{aligned}\underline{R}^{f}_{w,d} - \bar{R}^{f}_{w,d} &= \frac{(1-\theta)\underline{w}}{\underline{P}_d / (1+\theta)} - \frac{(1-\theta)\bar{w}}{\bar{P}_d / (1+\theta)} \\ \underline{R}^{f}_{w,x} - \bar{R}^{f}_{w,x} &= \frac{(1-\theta)\underline{w}}{\underline{e}\underline{P}^{*}_{x}} - \frac{(1-\theta)\bar{w}}{\bar{P}_x / (1+\theta)}\end{aligned} \tag{37}$$

2.2d BTA neutrality

The BTA neutrality conditions are:

$$
\begin{aligned}
&\underline{Q}_d = \bar{Q}_d \\
&\underline{M} = \bar{M} \text{ and } \frac{\underline{P}_m}{\underline{P}_d} = \frac{\bar{P}_m}{\bar{P}_d} \text{ or } \frac{\underline{e}\underline{P}_m^*}{\underline{P}_d} = \left(\frac{1}{1+\theta}\right)\frac{\bar{e}\bar{P}_m^*}{\bar{P}_d} \\
&\underline{X} = \bar{X} \text{ and } \frac{\underline{P}_x}{\underline{P}_d} = \left(\frac{1}{1+\theta}\right)\frac{\bar{P}_x}{\bar{P}_d} \text{ or } \frac{\underline{e}\underline{P}_x^*}{\underline{P}_d} = \frac{\bar{e}\bar{P}_x^*}{\bar{P}_d} \\
&\underline{L}_d = \bar{L}_d,\ \underline{L}_x = \bar{L}_x \text{ and } \frac{\underline{w}}{\underline{P}_d} = \frac{\bar{w}}{\bar{P}_d}
\end{aligned}
\tag{38}
$$

All eleven relative price constancy conditions are the same as in the VAT case.

When there is BTA neutrality, the difference in real tax receipts between the two regimes is given by:

$$
\frac{\underline{T}}{\underline{P}_d} - \frac{\bar{T}}{\bar{P}_d} = \theta\left(\frac{\underline{e}\underline{P}_m^*}{\underline{P}_d}\underline{M} - \frac{\underline{P}_x}{\underline{P}_d}\underline{X}\right) = \frac{\theta}{1+\theta}\left(\frac{\underline{P}_m}{\underline{P}_d}\underline{M} - \frac{(1+\theta)\underline{P}_x}{\underline{P}_d}\underline{X}\right) \tag{39}
$$

This is again the same as in the VAT case (equation (31)).

Because the BTA neutrality conditions and equation (39) are exactly the same for the (cash flow) CPT as for the VAT, and equation (1), linking dollar prices and euro prices of imports and exports, is also the same under the CTP and the VAT, the nominal exchange rate implications of a BTA under a cash flow CPT are the same as those for the VAT.

2.3 Interpreting the BTA neutrality conditions

Consider first equation (29). Import volumes are constant "from the demand side", if the relative price of imports to exports for consumers remains constant. Consumers pay the tax on imports in the destination regime. There is no tax on imports in the origin regime. In both the destination and the origin regimes, tax is paid on domestic goods. To keep the tax-inclusive relative price of imports to domestic goods, $\frac{P_m}{P_d}$, constant for consumers between the origin regime and the destination regime, the net-of-tax relative price of imports to domestic output has to fall by the same percentage as the tax rate. This is what the second line of equation (29) and the first and second lines of (30) state:

$$
\begin{aligned}
&\frac{\underline{P}_m}{\underline{P}_d} = \frac{\bar{P}_m}{\bar{P}_d} \\
&\text{and} \\
&\frac{\underline{e}\underline{P}_m^*}{\underline{P}_d} = \left(\frac{1}{1+\theta}\right)\frac{\bar{e}\bar{P}_m^*}{\bar{P}_d}
\end{aligned}
\tag{40}
$$

This means that $\frac{eP_m^*}{P_d}$ falls in the destination regime by the same percentage as the tax rate. With a constant *tax-exclusive* foreign currency price of imports, P_m^*, and a constant US dollar price of domestic goods, P_d, (tax-inclusive or net-of-tax does not matter for domestic goods as the tax rate on domestic goods is the same in the origin and destination regimes) this could be achieved by an appreciation of the US dollar nominal exchange rate by the same percentage as the tax rate : $\frac{\underline{e}}{\bar{e}} = \left(\frac{1}{1+\theta}\right)\frac{\underline{P}_d \bar{P}_m^*}{\underline{P}_m^* \bar{P}_d}$ in that case becomes $\frac{\underline{e}}{\bar{e}} = \frac{1}{1+\theta}$.[6].

The relative price of imports to domestic goods faced by US producers, $\frac{P_m}{P_d/(1+\theta)}$, will also be unchanged if $\frac{eP_m^*}{P_d}$ falls by the same percentage as the tax rate when the economy moves from an origin-based to a destination-based tax (line two of equation (29) and lines two and three of equation (30)).

A constant volume of exports between the origin and destination regimes requires that the *tax-inclusive* relative price of exports to domestic goods, $\frac{P_x}{P_d}$, is lower in the destination regime (where exporters are no longer taxed) than in the origin regime by the same percentage as the tax rate. Of course, net of the tax, the relative price of exports to domestic goods $\frac{eP_x^*}{P_d/(1+\theta)}$ will be the same in the origin and destination regimes. The export neutrality conditions are given in line three of equation (29) and line three of equation (30)):

$$\frac{\underline{P}_x}{\underline{P}_d} = \left(\frac{1}{1+\theta}\right)\frac{\bar{P}_x}{\bar{P}_d}$$
$$\text{and} \qquad (41)$$
$$\frac{\underline{e}\underline{P}_x^*}{\underline{P}_d} = \frac{\bar{e}\bar{P}_x^*}{\bar{P}_d}$$

From the export neutrality condition for the relative producer price of exports and domestic goods, $\frac{\underline{P}_x}{\underline{P}_d} = \left(\frac{1}{1+\theta}\right)\frac{\bar{P}_x}{\bar{P}_d}$, it follows that, if the US dollar price of exports *net of tax* - eP_x^* - is constant, the market price (or tax-inclusive price) dollar price of exports, P_x, will decline by the same percentage as

[6] The tax rate on domestically produced and sold goods remains constant, to the issue of whether the stickiness of the dollar price of domestically produced and sold goods refers to the tax-exclusive price or the tax-inclusive price does not arise.

the tax rate and the dollar price of domestic goods can remain constant. If the euro price of US imports is constant net of tax, this can only be achieved by a proportional appreciation of the nominal US dollar exchange rate equal in percentage terms to the tax rate. It that case the net-of-tax euro price of US exports, P_x^*, will not change between the origin and destination regimes.

However, if it is instead the *tax-inclusive* dollar price of exports, P_x, that is fixed, the relative producer price of exports to domestic goods can remain constant, when the economy moves from the origin to the destination, only if the dollar price of domestic goods, P_d, rises by the same percentage as the tax rate. The condition $\frac{e\underline{P}_x^*}{\underline{P}_d} = \frac{\bar{e}\bar{P}_x^*}{\bar{P}_d}$ can then only be satisfied if the tax-exclusive dollar price of exports, eP_x^*, *rises* by the same percentage as the tax rate. With a constant *tax-inclusive* euro price of US imports, this would require a depreciation of the US dollar nominal exchange rate by the same percentage as the tax rate.

The export and import neutrality conditions can also be written in terms of the relative price of imports and exports, or the terms of trade, inclusive of the tax and exclusive of the tax, in the two regimes:

$$\frac{\underline{P}_m}{\underline{P}_x} = (1+\theta)\frac{\bar{P}_m}{\bar{P}_x} \text{ or } \frac{e\underline{P}_m^*}{\underline{P}_x} = \frac{\bar{e}\bar{P}_m^*}{\bar{P}_x}$$
$$\text{and} \qquad (42)$$
$$\frac{\underline{P}_m^*}{\underline{P}_x^*} = \left(\frac{1}{1+\theta}\right)\frac{\bar{P}_m^*}{\bar{P}_x^*} \text{ or } \frac{\underline{P}_m}{e\underline{P}_x^*} = \frac{\bar{P}_m}{\bar{e}\bar{P}_x^*}$$

The leftmost equations in (42) represents the intuitive result that the *tax-inclusive* relative price of imports to exports *rises* by the same percentage as the tax rate and that the *tax-exclusive* relative price of imports to exports *falls* by the same percentage as the tax rate. The rightmost equations in (42) make the equivalent but rather less intuitive statement, that the ratio of the net-of-tax price of imports to the tax-inclusive price of exports is constant, and that the ratio of the price of imports including tax to the price of exports net-of -tax is constant.

Equations (40) and (41) convey the same message as equation (42). Equation (40) states that the tax-inclusive relative price of US imports to domestic goods remains the same while the tax-exclusive relative price of US imports to domestic goods falls by the same percentage as the tax rate. Equation (41) states that the tax-inclusive relative price of exports to domestic goods falls by the same percentage as the tax rate and that that the tax-exclusive relative price of exports to domestic goods remains constant.

2.4 Labor supply

Note that constancy of the real product wage in the domestic goods sector (line five of equation (30)) and constancy for consumers of the relative price of imports and domestic output (line one of equation (30)) imply that the domestic household's real consumption wage is also constant between the two regimes if there is BTA neutrality (line four of equation (30)). Even if the supply of labor is not inelastic with respect to the real wage, there will be no change in the supply of labor across the two regimes.

2.5 Revenue neutrality

In static (one-period) models, BTA neutrality requires balanced trade. Strictly speaking, in a one-period model, we cannot analyze an economy moving in real time from an origin-based to a destination-based system of taxation. We can only compare two 'parallel universes', one of which is characterized by an origin-based tax system and the other by a destination-based tax system. Feldstein and Krugman (1990), however, develop a two-period model. In this model balanced trade in each period is not necessary for BTA neutrality. Instead, the present discounted value (PDV) of exports must equal the PDV of imports – there is a zero net foreign debt position at the beginning of period 1. In a general multi-period model, this generalizes to the requirement that the PDV of exports equals the PDV of imports plus the net external debt of the country.

If there is BTA neutrality, the one-period change in real tax revenues is given by:

$$\frac{\underline{T}}{\underline{P}_d} - \frac{\bar{T}}{\bar{P}_d} = \theta\left(\frac{\bar{e}\bar{P}_m^*}{\bar{P}_d}\bar{M} - \frac{\bar{e}\bar{P}_x^*}{\bar{P}_d}\bar{X}\right) = \left(\frac{\theta}{1+\theta}\right)\left(\frac{\underline{P}_m}{\underline{P}_d}\underline{M} - \frac{(1+\theta)\underline{P}_x}{\bar{P}_d}\underline{X}\right) \tag{43}$$

Assume BTA neutrality holds for real after-tax profits and for all volumes and relative prices. What happens to real tax revenues?

The US is a country with a trade deficit. Equation (43) shows that a country with a trade deficit raises its real tax revenue by switching from an origin-based to a destination-based tax. However, if the US private and public sectors 'live within their means', that is, satisfy their intertemporal budget constraints, then the USA economy as a whole will satisfy the requirement that the PDV of its current and future exports plus its stock of net foreign assets are no smaller than the PDV of current and future imports. The US is a net debtor country. Assuming the US is and expects to remain solvent, this means that the PDV of current and future exports exceeds the PDV of current and future imports. With a constant tax rate, the long-run effect of a BTA on the PDV of future taxes is therefore negative.

The US is in the unusual position of having a persistent surplus on its external investment income account at the same time that it is reported to be a net foreign debtor. The return on US foreign assets is higher than the return on US assets owned by foreigners. The 'dark matter' that accounts for this difference is the subject of many studies. Some of it is no doubt due to the unique status of the US dollar as the world's only significant reserve currency. Whatever the truth will turn out to be, it is likely that the valuation of US external assets and liabilities is deficient: it does not represent a fair estimate of the PDV of future investment income earned abroad net of future investment income paid to foreigners. So the PDV tax loss from a BTA suggested by a superficial look at the data may be an overestimate and could even be wrong in sign. Regardless of what the true situation turns out to be, it would be helpful if our political masters did not just look at the impact of fiscal measures on the current (trade) deficit but instead took a long-term perspective.

2.6 BTAs and the WTO

One of the arguments against moving US corporate profit taxation to a destination basis is that the WTO would be opposed to it. The WTO does not object in principle to destination-based taxation for indirect taxes, like the VAT. It is unhappy about destination-based taxation for direct taxes, including the corporate profit tax (see Schön (2016) and Trachtman (2016)).

The argument against a BTA for the corporate profit tax is the following. Consider an economy where the same good can be imported or produced domestically (this is not necessary to generate a WTO objection, but it makes the issue very clear). With destination-based taxation, under a uniform VAT rate, both the imported good and the domestically produced good pay the same VAT rate on the full value of the good. Under a uniform rate cash flow CPT, the imported good would pay the corporate profit tax on the full value of the good while the domestic producer only pays tax on the profits made in the production of the good. The domestic producer has a fiscal advantage over the foreign producer of the imported good equal to the corporate tax rate times the payroll of the domestic producer. Unfair.

Indeed, but if BTA neutrality prevails, the producer's net-of-tax relative price of imports to US domestic goods falls by the same percentage as the CPT rate, so the tax-inclusive relative price of US imports and US domestic goods is constant. The decline in the before-tax relative price of imports to domestic goods applies to the full value of imports, not just to the profit component of the value of the imports: the cost advantage of the US producer granted by the 'payroll tax deduction' is exactly offset by the decline in the relative price of the foreign payroll component in US imports. I assume this means that the WTO does not believe in BTA neutrality.

But if the WTO does not believe in BTA neutrality, why doesn't it also object to a VAT with BTA? After all, without BTA neutrality a VAT BTA will indeed not discriminate between imports and domestic producers, but *relative to the origin-based VAT*, the destination-based VAT represents a competitive *change* in favour of US exporters (who were taxed in the origin regime but no longer are taxed in the destination regime) over foreign producers competing with US exports in foreign markets. It also represents a competitive *change* to the detriment of US importers who used to be exempt from taxation in the origin regime but no longer are in the destination regime. The WTO appears to focus on the presence or absence of a fiscal level playing field between domestic and foreign producers (assuming that there is no BTA adjustment at all, let alone full BTA neutrality) rather than on the *change* in the playing field levels caused by a BTA (absent BTA neutrality).

(3) Sixteen possible constant nominal price configurations and their exchange rate implications

It makes sense to consider all possible combinations, especially from a Keynesian perspective, according to which constant nominal prices are identified with (temporarily) fixed or sticky nominal prices and wages. There is no empirical evidence on whether nominal price and wage rigidities pertain to net-of-tax or tax-inclusive prices and wages. Likewise, there is only partial and inconclusive empirical evidence on whether destination currency pricing (pricing-to-market) or origin currency pricing is the norm.

It is true that much (intermediate) textbook analysis of open economies assumes that export prices are fixed in terms of the currency of the exporter (US export prices are fixed in the currency of origin (the US dollar)), and that import prices are likewise fixed in terms of the currency of the exporting country (US import prices are fixed in the currency of origin (the euro)). The theoretical or empirical justification for adopting the origin currency pricing convention is, however, never made clear.

The content of the sixteen matrix cells in Table 1 is derived as follows:

1. Constant net-of-tax euro price of imports and a constant net-of-tax dollar price of exports:

$$\underline{P}_m^* = \overline{P}_m^* \text{ or } \frac{\underline{P}_m}{(1+\theta)\underline{e}} = \frac{\overline{P}_m}{\overline{e}}$$

and (44)

$$\underline{P}_x = \frac{\overline{P}_x}{1+\theta} \text{ or } \underline{e}\underline{P}_x^* = \overline{e}\overline{P}_x^*$$

From the second line of equation (42), a constant net-of-tax euro price of imports, P_m^*, implies that the net-of-tax euro price of exports, P_x^*, has to rise by the same percentage as the tax rate: $\underline{P}_x^* = (1+\theta)\overline{P}_x^*$. Since the net-of-tax US dollar price of exports, eP_x^*, is constant, the nominal exchange rate of the US dollar has to appreciate by the same percentage as the VAT rate: $\frac{\underline{e}}{\overline{e}} = \frac{1}{1+\theta}$ or $\frac{\underline{e}-\overline{e}}{\overline{e}} = -\frac{\theta}{1+\theta}$. The tax-inclusive US dollar price of imports is constant: $\underline{P}_m = \overline{P}_m$. The dollar price of domestic output, P_d, and the US money wage, w, are also constant. The US real consumption wage and the real product wages in the domestic goods , and the export sector are constant. The euro price of domestic goods in the Eurozone, $P_{d^*}^*$, is constant, as is the Eurozone money wage in euro, w^*.

This is the conventional wisdom outcome.

2. Constant tax-inclusive dollar price of imports and a constant tax-inclusive euro price of exports:

$$\underline{P}_m = \overline{P}_m \text{ or } (1+\theta)\,\underline{e}\underline{P}_m^* = \overline{e}\overline{P}_m^*$$

and (45)

$$\underline{P}_x^* = (1+\theta)\overline{P}_x^* \text{ or } \underline{P}_x = \frac{\underline{e}\overline{P}_x}{\overline{e}}$$

From the first line of equation (42) it is clear that, if $\underline{P}_m = \overline{P}_m$, the tax-inclusive US dollar price of exports, P_x, falls by the same percentage as the tax rate: $\underline{P}_x = \frac{\overline{P}_x}{1+\theta}$. From the second line of (45) this requires an appreciation of the nominal US dollar exchange rate by the same percentage as the tax rate. With a constant tax-inclusive dollar US price of imports, the consumer's relative price of imports to domestic goods can only be constant if the dollar price of domestic goods, P_d, is constant. The US money wage in dollars is constant and so are the Eurozone price of Eurozone domestic goods in euro and the Eurozone money wage in euro.

This is the only other set of nominal pricing assumptions that supports the conventional wisdom that a neutral US BTA causes the nominal US dollar exchange rate to appreciate by the same percentage as the tax rate.

3. Constant tax-inclusive euro price of imports, and a constant tax-inclusive US dollar price of exports:

$$(1+\theta)\underline{P}_m^* = \overline{P}_m^* \text{ or } \frac{\underline{P}_m}{\underline{e}} = \frac{\overline{P}_m}{\overline{e}}$$

and (46)

$$\underline{P}_x = \overline{P}_x \text{ or } \underline{e}\underline{P}_x^* = (1+\theta)\overline{e}\overline{P}_x^*$$

This means that, when we move from the origin-based tax to the destination-based tax, the euro import price net of tax, P_m^*, *falls* by the same percentage as the tax rate and that the domestic currency export price net of tax, $\frac{P_x}{1+\theta} = eP_x^*$, *rises* by the same percentage as the tax rate. The neutrality conditions for the relative price of imports and exports (tax-inclusive and net-of-tax) given inequation (42) and equation (46) imply that $\underline{P}_x^* = \overline{P}_x^*$. Since $\underline{P}_x = \overline{P}_x$ it follows that $\underline{e}\underline{P}_m^* = \overline{e}\overline{P}_m^*$. Since $(1+\theta)\underline{P}_m^* = \overline{P}_m^*$ it follows that $\frac{\underline{e}}{\overline{e}} = 1+\theta$ or $\frac{\underline{e}-\overline{e}}{\overline{e}} = \theta$. Note that with a constant tax-inclusive export price in US dollars, $\underline{P}_x = \overline{P}_x$, the relative price for domestic consumers of exports net of tax to domestic goods can remain constant only, $\frac{\underline{P}_x}{\underline{P}_d} = \left(\frac{1}{1+\theta}\right)\frac{\overline{P}_x}{\overline{P}_d}$, if the dollar price of domestic goods, P_d, rises by the same percentage as the tax rate. This means that, since $\frac{\underline{P}_m}{\underline{P}_d} = \frac{\overline{P}_m}{\overline{P}_d}$, the US dollar price of imports, inclusive of tax, P_m, also has to rise by the same percentage as the tax rate. The euro price of foreign goods produced for the foreign market, $P_{d^*}^*$ will *fall* by the same percentage as the tax rate (line seven of equation (30). The euro price of exports, net of tax, P_x^* is constant and the euro price of exports inclusive of tax *falls* by the same percentage as the tax rate. The US money wage in dollars rises by the same percentage as the tax rate and the Eurozone money wage in euro falls by the same percentage.

4. Constant net-of-tax dollar price of imports and a constant net-of-tax euro price of exports:

$$\frac{\underline{P}_m}{1+\theta} = \overline{P}_m \text{ or } \underline{e}\underline{P}_m^* = \overline{e}\overline{P}_m^*$$
$$\underline{P}_x^* = \overline{P}_x^* \text{ or } \frac{\underline{P}_x}{\underline{e}} = \frac{\overline{P}_x}{(1+\theta)\overline{e}} \quad (47)$$

To satisfy the import pricing assumption, the tax-inclusive dollar price of imports, P_m, has to rise by the same percentage as the tax rate. From the first line of equation (42), the tax-inclusive US dollar price of exports, P_x, is constant. From the second line of (47) this implies that the nominal exchange rate of the US dollar *depreciates* by a percentage equal to the tax rate: $\frac{\underline{e}}{\overline{e}} = 1+\theta$ or $\frac{\underline{e}-\overline{e}}{\overline{e}} = \theta$. To preserve import neutrality, the dollar price of domestically produced and sold goods, P_d, has to rise by a percentage equal to the tax rate. The US money wage in dollars rises by the same percentage. Since the foreign currency price of exports (net of tax) is constant by assumption, the foreign currency price of exports including tax declines by the same percentage as the tax rate. The Eurozone price of Eurozone

domestic goods in euro and the Eurozone money wage in euro fall by the same percentage as the tax rate.

Cases (3) and (4) are the only nominal price constancy configurations that support a depreciation of the dollar by the same percentage as the tax rate.

5. Constant net-of-tax import price in euro and constant net-of-tax export price in euro:

$$\underline{P}_m^* = \bar{P}_m^*$$
$$\text{and} \qquad (48)$$
$$\underline{P}_x^* = \bar{P}_x^*$$

Equation (48) implies that the relative price of imports and exports (net-of-tax) is constant: $\frac{\underline{P}_m^*}{\underline{P}_x^*} = \frac{\bar{P}_m^*}{\bar{P}_x^*}$.

But from equation (42) we know that it is a requirement of BTA neutrality that the net-of-tax relative price of imports to exports *falls* by the same percentage as the tax rate. The nominal price constancy assumptions in equation (48) are therefore inconsistent with BTA neutrality. This may seem to contradict the analysis in Feldstein and Krugman (1990), who make the assumption that nominal net-of-tax export and import prices are constant in foreign currency and conclude that this implies a constant nominal exchange rate. However, Feldstein and Krugman compare an initial equilibrium without a tax with the equilibrium following the introduction of a destination-based VAT. In this paper the initial situation is one with an origin-based VAT (or CPT). There is no contradiction between the analysis in this paper and the analysis in the Feldstein and Krugman paper.

6. Constant tax-inclusive export price in euro and constant tax-inclusive import prices in euro:

$$(1+\theta)\underline{P}_m^* = \bar{P}_m^*$$
$$\text{and} \qquad (49)$$
$$\underline{P}_x^* = (1+\theta)\bar{P}_x^*$$

This implies $\frac{\underline{P}_m^*}{\underline{P}_x^*} = \left(\frac{1}{1+\theta}\right)^2 \frac{\bar{P}_m^*}{\bar{P}_x^*}$, which is, from equation (42) also inconsistent with BTA neutrality.

7. Constant net-of-tax import price in US dollars and constant net-of-tax export price in US dollars:

$$\frac{\underline{P}_m}{(1+\theta)} = \bar{P}_m$$
$$\text{and} \qquad (50)$$
$$\underline{P}_x = \frac{\bar{P}_x}{1+\theta}$$

This implies $\frac{\underline{P}_m}{\underline{P}_x} = (1+\theta)^2 \frac{\overline{P}_m}{\overline{P}_x}$ which is inconsistent with one of the BTA neutrality requirements in equation (42), that the tax-inclusive relative price of imports to exports rises by the same percentage as the tax rate $\frac{\underline{P}_m}{\underline{P}_x} = (1+\theta)\frac{\overline{P}_m}{\overline{P}_x}$.

8. Constant tax-inclusive import price in US dollars and constant tax-inclusive export price in US dollars:

$$\begin{aligned} &\underline{P}_m = \overline{P}_m \\ &\text{and} \\ &\underline{P}_x = \overline{P}_x \end{aligned} \tag{51}$$

This implies that the tax-inclusive relative price of imports to exports is constant while, from equation (42), BTA neutrality requires it to rise by the same percentage as the tax rate: $\frac{\underline{P}_m}{\underline{P}_x} = (1+\theta)\frac{\overline{P}_m}{\overline{P}_x}$. Again this is inconsistent with BTA neutrality.

9. Constant net-of-tax import price in euro and constant tax-inclusive export price in US dollars:

$$\begin{aligned} &\underline{P}_m^* = \overline{P}_m^* \quad \text{or} \quad \frac{\underline{P}_m}{(1+\theta)\overline{e}} = \frac{\overline{P}_m}{\overline{e}} \\ &\text{and} \\ &\underline{P}_x = \overline{P}_x \quad \text{or} \quad \underline{e}\underline{P}_x^* = (1+\theta)\overline{e}\overline{P}_x^* \end{aligned} \tag{52}$$

From equation (42) this produces a constant nominal exchange rate, $\underline{e} = \overline{e}$, a tax-inclusive dollar price of imports, P_m , that rises by a percentage equal to the tax rate, a tax-exclusive dollar price of exports, eP_x^* , that rises by a percentage equal to the tax rate, a tax-exclusive euro price of exports, P_x^* , that rises by the same percentage as the tax rate, a US dollar price of US domestic output, P_d , and a US dollar wage, w , that rise by the same percentage as the tax rate, and a Eurozone domestic output price in euro, P_d^* , that is constant.

10. Constant net-of-tax import price in US dollars and constant tax-inclusive export price in US dollars:

$$\begin{aligned} &\underline{P}_m = (1+\theta)\overline{P}_m \\ &\text{and} \\ &\underline{P}_x = \overline{P}_x \end{aligned} \tag{53}$$

In this case, the nominal exchange rate is indeterminate and the tax-inclusive and net-of-tax euro prices of imports and exports are also indeterminate. Only relative prices are determinate.

11. Constant tax-exclusive import price in euro and constant tax-inclusive export price in euro:

$$\underline{P}_m^* = \overline{P}_m^*$$
$$\text{and} \tag{54}$$
$$\underline{P}_x^* = (1+\theta)\overline{P}_x^*$$

In this case, the nominal exchange rate is indeterminate and the tax-inclusive and net-of-tax dollar prices of imports and exports are also indeterminate. Only relative prices are determinate.

12. Constant net-of-tax import prices in dollars and constant tax-inclusive export prices in euro:

$$\underline{P}_m = (1+\theta)\overline{P}_m$$
$$\text{and} \tag{55}$$
$$\underline{P}_x^* = (1+\theta)\overline{P}_x^*$$

This requires a constant nominal exchange rate, a constant tax-inclusive dollar price of exports and a constant net-of-tax euro price of imports, $\underline{e} = \overline{e}$, $\underline{P}_x = \overline{P}_x$ and $\underline{P}_m^* = \overline{P}_m^*$.

13. Constant tax-inclusive import price in euro and constant net-of-tax export price in US dollars:

$$(1+\theta)\underline{P}_m^* = \overline{P}_m^*$$
$$\text{and} \tag{56}$$
$$\underline{P}_x = \frac{\overline{P}_x}{1+\theta}$$

This requires a constant nominal exchange rate, a constant net-of-tax export price in euro and a constant tax-inclusive import price in US dollars, $\underline{e} = \overline{e}$, $\underline{P}_x^* = \overline{P}_x^*$ and $\underline{P}_m = \overline{P}_m$.

14. Constant tax-inclusive import price in US dollars and constant net-of-tax export price in US dollars:

$$\underline{P}_m = \overline{P}_m$$
$$\text{and} \tag{57}$$
$$\underline{P}_x = \frac{\overline{P}_x}{1+\theta}$$

In this case, the nominal exchange rate is indeterminate and the tax-inclusive and net-of-tax euro prices of imports and exports are also indeterminate. Only relative prices are determinate.

15. Constant tax-inclusive import price in US dollars and constant net-of-tax export price in euro:

$$\underline{P}_m = \overline{P}_m$$
$$\text{and} \tag{58}$$
$$\underline{P}_x^* = \overline{P}_x^*$$

This requires a constant nominal exchange rate, a net-of-tax euro price of imports that falls by the same percentage as the tax rate and a tax-inclusive dollar price of exports that falls by the same percentage as the tax rate, $\underline{e} = \bar{e}$, $\underline{P}_x = \dfrac{\bar{P}_x}{1+\theta}$ and $\underline{P}_m^* = \dfrac{\bar{P}_m^*}{1+\theta}$

16. Constant tax-inclusive import prices in euro and constant net-of-tax export price in euro:

$$\underline{P}_m^*(1+\theta) = \bar{P}_m^*$$
$$\text{and} \tag{59}$$
$$\underline{P}_x^* = \bar{P}_x^*$$

In this case the nominal exchange rate and export and import prices (net of tax and tax-inclusive) in dollars are indeterminate.

When both import and export prices are constant in the same currency, we either have an indeterminate nominal exchange rate (if import prices are constant net-of-tax and export prices are constant including the tax or vice versa) or BTA neutrality is violated (if both import and export prices are constant net-of-tax or both a constant including tax).

So of the 16 possible nominal price constancy regimes, two yield an appreciation by the same percentage as the tax rate, two yield a depreciation by the same percentage as the tax rate, four yield a constant nominal exchange rate, four yield an indeterminate nominal exchange rate and four are inconsistent with BTA neutrality.

In what follows I will only consider the two currency appreciation configurations and the two currency depreciation configurations. There is nothing to say about the inconsistent and the indeterminate cases. The constant exchange rate configurations have import prices constant net-of-tax but export prices constant including tax or vice versa. I consider such asymmetry to be implausible and therefore ignore the constant exchange rate configurations.

4. Interpreting the four a-priori plausible scenarios

In all four scenarios, the tax-inclusive relative price of imports to exports rises by the same percentage as the tax rate and that the net-of-tax relative price of imports to exports falls by the same percentage as the tax rate.

(4.1). Exchange rate appreciation

(4.1a) The 'Keynesian' case with net-of-tax prices constant

Exchange rate appreciation occurs under a neutral BTA when nominal import and export prices are constant net-of-tax and when import prices (net-of-tax) are constant in foreign currency (euro) and export prices (net-of-tax) are constant in domestic currency (dollar). As noted earlier, this 'origin currency pricing' is the assumption made in most intermediate macroeconomics textbooks with a Keynesian flavor, although these models don't consider the net-of-tax vs. tax-inclusive pricing issue.

In this case, with the net-of-tax price of US exports constant in dollars, the BTA results in a decline in the tax-inclusive price of exports in dollars, by the same percentage as the tax rate. The appreciation of the dollar by that same percentage means that the tax-inclusive price of exports in euro is unaffected by the BTA.

With the net-of-tax price of US imports constant in euro, the tax-inclusive price of imports in euro rises by the same percentage as the tax rate. The appreciation of the dollar by that same percentage means that the tax-inclusive price of imports in dollars is unchanged.

The dollar price of US goods produced for the US domestic market and US money wages in dollars remain unchanged. The foreign currency price of foreign goods produced for the foreign market remains unchanged and so is the foreign money wage in euro.

The price of US domestic goods in dollars, the US money wage in dollars, and the euro price of Eurozone domestic goods in euro and the Eurozone money wage in euro all remain constant.

This case has no inflation or deflation either in the home country or in the foreign country.

(4.1b) Pricing-to-market with tax-inclusive prices constant

Exchange rate appreciation also occurs under a neutral BTA if tax-inclusive prices are constant and the (tax-inclusive) price of US imports is constant in dollars and the (tax-inclusive) price of US exports is constant in euro. This 'destination currency pricing' or 'pricing-to-market' has considerable empirical support (see Section 5 below), although, again, the issue of tax-inclusive vs. net-of-tax pricing is not considered in this literature.

In this case, with, from equations (1), (42) and (45), the tax-inclusive price of US exports constant in euro, the net-of-tax euro price of exports rises by the same percentage as the tax rate when the BTA occurs. The appreciation of the dollar by that same percentage means that the net-of-tax dollar price of exports is constant and that the tax-inclusive dollar price of exports falls by the same percentage as the tax rate.

With the tax-inclusive price of US imports constant in dollars, the BTA causes the net-of-tax dollar price of US imports to fall by the same percentage as the tax rate. The appreciation of the dollar means that the net-of-tax euro price of US imports is constant. The tax-inclusive euro price of US imports rises by the same percentage as the tax rate. The dollar price of US goods produced for the US market the US money wage in dollars, the euro price of foreign goods produced for the foreign market and the foreign money wage in euro remain constant. Again, there is no inflation or deflation in the home country or the foreign country.

(4.2) Exchange rate depreciation

(4.2a) The 'Keynesian case with tax-inclusive prices constant

Exchange rate depreciation occurs under a neutral BTA when tax-inclusive prices are constant and (tax-inclusive) US export prices are constant in dollars and (tax-inclusive) US import prices are constant in euro – the case of (tax-inclusive) origin currency pricing for both imports and exports.

With tax-inclusive US export prices constant in dollars, net-of-tax US export prices (in dollars) rise by the same percentage as the tax rate as a result of the BTA. The dollar depreciates by the same percentage as the tax rate so the net-of-tax euro price of US exports remains constant and the tax-inclusive euro price of US exports falls by the same percentage as the tax rate.

With the tax-inclusive euro price of US imports constant, the net-of tax euro price of US imports falls by the same percentage as the tax rate. Because of the dollar depreciation, the tax-inclusive dollar price of US imports rises by the same percentage as the tax rate and the net-of-tax dollar price of US imports is constant.

The dollar price of US goods produced for the domestic market and the US money wage in dollars rise by the same percentage as the tax rate. The euro price of foreign goods produced for the foreign market falls by the same percentage as the tax rate and so does the foreign money wage in euro.

This case therefore has (temporary) inflation in the country implementing the BTA and (temporary) deflation in the foreign country.

(4.2b) Pricing-to-market with net-of-tax prices constant

Exchange rate depreciation also occurs under a neutral BTA when net-of-tax prices are constant and (net-of-tax) US export prices are constant in euro and (net-of-tax) US import prices are constant in dollars. This is the case of net-of-tax destination currency pricing or net-of-tax pricing-to-market.

With net-of-tax US export prices constant in euro, tax-inclusive US export prices in euro fall by the same percentage as the tax rate. The dollar depreciates by the same percentage as the tax rate, so the tax-inclusive US export price in dollars is constant and the net-of-tax US export price in dollars rises by the same percentage as the tax rate.

With net-of-tax US import prices constant in dollars, tax-inclusive US import prices in dollars rise by the same percentage as the tax rate. With the dollar depreciating by that same percentage, the net-of-tax US import price in euro falls by the same percentage as the tax rate and the tax-inclusive US import price in euro is constant.

The dollar price of US goods produced for the domestic market and the US money wage in dollars rise by the same percentage as the tax rate. The euro price of foreign goods produced for the foreign market falls by the same percentage as the tax rate and so does the foreign money wage in euro. This case therefore also has (temporary) inflation in the country implementing the BTA and (temporary) deflation in the foreign country.

(5) Which nominal price constancy assumptions are the most plausible?

Anyone with a Keynesian view of nominal wage and price rigidities will be comfortable with the dollar appreciation scenarios but not with the dollar depreciation scenarios. The reason is that in the dollar appreciation scenarios the dollar price of US goods produced for the US market and the US money wage (in dollars) remain constant and so do the euro price of foreign goods produced for the foreign market and the foreign money wage in euro – consistent with the Keynesian view on the prevalence of nominal wage and price rigidities.

In the depreciation scenarios the dollar price of US goods produced for the US market and the US money wage in dollars rise by the same percentage as the tax rate. The euro price of foreign goods produced for the foreign market and the foreign money wage in euro fall by the same percentage as the tax rate. This would not be possible in a Keynesian world with symmetric nominal wage and price rigidities. Even if upward nominal wage and price rigidities are not present, but only downward nominal wage and price rigidities are, the decline in the foreign general price level and in the foreign money way would be problematic from a Keynesian perspective. Indeed from a strict downward nominal rigidity Keynesian perspective, the depreciation scenarios violate downward nominal price and wage rigidity and therefore must be rejected, leaving just the two appreciation scenarios.

This is not conclusive, however. First, Keynesian views on nominal wage and price rigidities are not universally held by members of the economics profession. Second, the temporary inflation in the US and the temporary deflation in the foreign country are, strictly speaking, a given proportional increase in the path of the current and future US general price level (in dollars) relative to some benchmark path and the same proportional fall in the path of the current and future foreign general price level (in euro) relative to some benchmark path. These benchmark paths could be characterized by positive inflation rates. The increase in the paths of the US general price level and money wage relative to the benchmark could therefore occur gradually through a temporarily higher rate of inflation and the fall in the paths of the foreign general price level and money wage relative to the benchmark could be achieved through a temporarily lower (but still positive) rate of inflation.

It therefore makes sense to look for direct empirical evidence on pricing-to-market, or destination currency pricing, vs. origin currency pricing and on tax-inclusive vs. net-of-tax pricing.

(5.1) Pricing-to-market

The pricing-to-market paradigm was created by Paul Krugman (1986), and a large number of empirical studies have tested it. Examples include, apart from Krugman (1986), Marston (1989), Blinder et. al. (1998), FitzGerald and Shortall (1998), Gil-Pareja (2003), Warmedinger (2004), Fitzgerald and Haller (2014), and Asprilla et. al. (2015).

A typical example of the empirical findings is Gil-Pareja (2002), whose study of pricing-to-market in European car markets during 1993 and 1998 found that, for imported cars, price stability in terms of the local currency is a strong and pervasive phenomenon. Interestingly, this 'destination currency' price stability (or stickiness) was independent of the invoicing currency, which in many cases was the origin currency. Most other empirical studies find some evidence of pricing-to-market, but the strength of the phenomenon varies between countries, sectors, industries and even firms, as well as over time. I consider pricing-to-market to be the best simple characterization of the pricing behaviour of exporters in their export markets, but at the same time recognize that the fit is far from perfect and, for certain products and countries, downright poor.

(5.2) Tax-inclusive v. net-of-tax pricing

Much to my surprise, I have not been able to find any empirical studies that directly address this issue. Most empirical studies studying wage setting at the micro level don't mention the word 'tax' (see e.g. Heckel et. al. (2012)). A study providing a tax-based test for nominal rigidities (Poterba et. al. (1986)) simply *assumes* on grounds of a-priori plausibility that nominal wage rigidity applies to the net-of-tax

money wage. In the literature on the incidence of taxes (trying to distinguish between who pays a tax (where the tax is collected) from who bears that tax after allowing for the general equilibrium effects of the tax on wages, prices, capital accumulation etc.), evidence is cited (see e.g. Dye (1984), OECD (1990), Bell et. al. (2002), Auerbach et. al. (2010), Ebrahimi and Vaillancourt (2016)), that a payroll tax levied on the workers directly reduces the after-tax money wage of the worker, without any necessary effect on the wage including the payroll tax. In this case, there is no effect on the nominal prices set by firms: the reduction in the after-tax money wage is the same, proportionally, as the reduction in the after-tax real wage. When the payroll tax is instead levied on the employer, the worker's nominal wage does not change but there tends to be an increase in the nominal price of the products produced and sold by the firm. The worker still pays the tax in full, when the supply of labor is inelastic, in the sense that the real wage falls by a percentage equal to the tax rate, but this occurs through an increase in the general price level, including the cost of the consumption bundle of the worker, by a percentage equal to the employers' payroll tax rate.

This phenomenon, even if it is indeed empirically robust, does not resolve the question of whether constant net-of-tax pricing or constant tax-inclusive pricing is the norm. In the case of the payroll tax paid by the worker, the example just cited has *tax-inclusive* constant nominal wages. In the case of the payroll tax paid by the employer, the example just cited has *net-of-tax* constant nominal output prices. The range of views on the mechanisms through which workers ultimately bear (part of) the cost of any payroll tax is exemplified by contrasting the view that a payroll tax paid by employers will reduce workers' real wages through higher prices and unchanged money wages with the view held by the CBO that *"… employers' share of payroll taxes is passed on to employees in the form of lower wages than would otherwise be paid*[7] (see also OECD (1990) Ebrahimi and Vaillancourt (2016)). Most studies of tax incidence focus on real wages, without breaking down real wage changes into nominal wage and general price level changes (e.g. Gavrilova et. al. (2015)).

(6) Conclusion

This paper offers a theoretical analysis of what happens to the nominal exchange rate when there is a border tax adjustment and this BTA is neutral. The answer is: we don't know. Of the nominal pricing assumption combinations that support the four interesting cases, two conclude that the currency will strengthen (appreciate) by the same percentage as the tax rate. Two other sets of nominal pricing assumptions support a weakening or depreciation of the currency by the same percentage as the tax rate.

Personally, if I had to choose a single currency/tax inclusiveness or tax exclusiveness combination, I would opt for the pricing-to-market/destination currency pricing assumption (US import prices are

[7] "CBO's analysis of effective tax rates assumes that households bear the burden of the taxes that they pay directly, such as individual income taxes and employees' share of payroll taxes. CBO assumes—as do most economists—that employers' share of payroll taxes is passed on to employees in the form of lower wages than would otherwise be paid. Therefore, the amount of those taxes is included in employees' income, and the taxes are counted as part of employees' tax burden." http://www.cbo.gov/sites/default/files/EffectiveTaxRates2006.pdf Page 3.

constant in dollars and US export prices are constant in euro) and probably (but without much conviction) the constant net-of-tax pricing assumption. That would produce the depreciation outcome. Anyone who firmly holds the view that origin currency pricing rules the roost (US export prices are constant in dollars and US import prices are constant in euro) will get the appreciation outcome if nominal prices are assumed to be constant *net-of-tax*. Origin currency pricing with constant *tax-inclusive* nominal prices would yield the depreciation outcome.

Empirical evidence weakly supports pricing-to-market, but recognizes that the appropriate assumption may well differ between countries, industries and firms and over time.. There is no empirical evidence on tax-inclusive vs. net-of-tax pricing.

The uncertainty facing anyone trying to take a view on the impact of a BTA on the dollar is even greater than indicated thus far in this Conclusion. Throughout this note, the maintained assumption has been that BTA neutrality holds. That, of course, is a contested empirical matter.

As regards BTAs involving a cash flow corporate profit tax, there is no history and there are no data to inform us. As regards BTAs involving a VAT we have a number of historical examples, most notably the introduction of a destination-based VAT in the EU. An extensive empirical evaluation of the EU record (Institute for Fiscal Studies (2011)) offers qualified support for the neutrality hypothesis. Econometric estimation of the degree to which the historical experience was consistent with BTA neutrality does, of course, rely on a large number of untested and generally untestable identifying assumptions. The estimated 'degree of neutrality' varies across countries and sectors (see also Desai and Hines (2005), Danninger and Carare (2008), Benedek et. al. (2016) and Liu and Lockwood (2016)).

A further unavoidable complication is that real-world VATs and CPTs don't have the universal uniform tax rate for all goods and services assumed by the theory. There are multiple VAT rates, exemptions and zero ratings. The same will undoubtedly be the case should the US implement a BTA for its corporate profit tax. Widespread ignorance of and/or lack of faith in the BTA neutrality proposition will lead importers to plead for reduced tax rates or exemptions. So even if all other assumptions necessary to produce BTA neutrality were satisfied, the fact that we are bound to have a very poor approximation to a true BTA means that there will be no neutrality.

Finally, even if the US were to implement an ideal-type corporate profit tax BTA, and even if all the conditions for BTA neutrality were satisfied, there are many other factors influencing the nominal and real exchange rates of the dollar: fiscal policy (including anticipated future fiscal policy) at home and abroad, monetary policy (including anticipated future monetary policy) at home and abroad, changes in risk aversion, changes in risk perceptions, capital controls and foreign exchange controls, fear of sovereign default, fear of a currency union break-up etc. etc.

Many of these factors are unobservable and they are likely to change frequently and significantly. So even if there were certainty that a possible future US corporate profit tax BTA would be completely neutral, and even if a currency investor were fully confident about the sign and magnitude of the response of the dollar exchange rate, should a BTA occur, it would be very difficult to determine how much of the BTA neutrality-driven exchange rate appreciation or depreciation had already been priced into spot, forward and options markets for the dollar and other currencies.

So, in the spirit of Socrates, we have to say about the exchange rate implications of a BTA: I know I know nothing, but at least I know that. The main lesson of this paper is that it would be unwise to think of the exchange rate effect of a corporate profit tax BTA as a one-way bet that the US dollar will strengthen. Not only don't we know the *magnitude* of the exchange rate effect of a BTA, we don't even know the *sign*.

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