The Macroeconomic Effects of Trade Policy*

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Abstract

We study the macroeconomic effects of trade policies that are often described as equivalent, namely a uniform increase in import tariff and export subsidy (IX), a value-added tax increase accompanied by a payroll tax reduction (VP), and a border-adjustment of corporate profit taxes (BAT). Using a dynamic New Keynesian open-economy framework, we show that BAT and IX policies are generically equivalent, but VP is not as nominal price rigidities shift the incidence of the value-added tax. This result holds under a wide range of assumptions, including fixed as well as flexible exchange rates, alternative pricing schemes, and different sources of nominal rigidities. The unilateral implementation of BAT or IX increases domestic output, appreciates the exchange rate, and reduces output abroad, whereas the unilateral implementation of VP is contractionary. The three policies are equivalent and have no allocative effects with permanent tax changes and producer currency pricing.

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1 Introduction

There is a longstanding debate about how trade policies can stimulate the macroeconomy. In the context of evaluating the merits of remaining on the gold standard during the early phases of the Great Depression, Keynes (1931) argued that the U.K. could derive a similar degree of stimulus from raising import tariffs and reducing export tariffs as through devaluing the pound against gold. Thirty years later, Mundell (1961) noted that the mercantilist element of this Keynesian policy would be inapplicable to countries that do not peg the nominal exchange as "the equilibrium in the balance of payments is automatically maintained by variations in the price of the foreign exchange rate".

In this article, we examine the macroeconomic effects of alternative trade policies in a two-country DSGE model that builds on contributions by Gali and Monacelli (2005) and Farhi et al (2014). In our benchmark model, producer prices are sticky as in Calvo (1983) and firms allow full pass through of exchange rate and tax changes into export prices, but we explore the sensitivity of our findings under different sources of nominal price rigidity (such as menu cost and wage stickiness) or alternative pricing schemes (such as local currency pricing). Although our interest is mainly on the effects of trade policies under floating exchange rates, we nonetheless also compare and contrast the transmission under different exchange rate regimes.

In our analysis, we restrict our attention to trade policies that are often considered to be equivalent. We first consider the Keynesian prescription of directly manipulating prices of traded goods through a uniform increase in import tariffs and export subsidies (IX henceforth). We next turn our attention to the effects of an increase in value-added taxes accompanied by a reduction in employer payroll contributions (VP), another policy that may change relative prices in a manner similar to import and export subsidies (see, for example, Farhi et al. (2014)). Finally, we analyze the effects of a border-adjustment of corporate profit taxation (BAT). Border-adjustment of taxes is an issue widely studied in the context of value-added taxation and flexible prices (see, for example, Meade (1977), Grossman (1980), and Feldstein and Krugman (1990)). More recently, several authors, including Auerbach and Holtz-Eakin (2016), Auerbach et al. (2017), have argued that a border adjustment of corporate taxation

would be equivalent to VP.

One key finding of our analysis is that an IX policy can have substantial allocative effects even under floating exchange rates. These policies clearly stimulate aggregate demand if the exchange rate is fixed and interest rate unresponsive, as hypothesized by Keynes and formalized in Farhi et al (2014). Using our benchmark model, we show that higher import tariffs and export subsidies boost GDP and inflation under a Taylor-style reaction function, with the size of the effects depending on the response of monetary policy. Moreover, because the stimulus arises through stronger net exports, foreign economies tend to be hurt through expenditure-switching channels.

This finding runs counter to the implication of some economic models which – drawing on familiar Mundell-Fleming reasoning – suggest that the exchange rate will adjust enough to fully offset the effects of changes in import and export tariffs on the domestic economy. The crux of this argument relies on a transversality condition which pins down the long-run behavior of the real exchange rate based on the requirement for intertemporal trade balance. In particular, if the new regime with higher tariffs and export subsidies is expected to remain permanently in place, the home exchange rate must jump to its new long-run value in order to avoid (explosive) growth in the current account surplus. Given uncovered interest parity, the home exchange rate appreciates immediately to insulate trade prices from the effects of the tax changes, so that there are no effects on domestic output, prices, or interest rates.

By contrast, our analysis envisions some chance of future regime shift – i.e., that the IX policy will be reversed – that damps the appreciation of the real exchange rate in the long-run. The implication of a smaller long-run appreciation means that the IX policy would provide substantial aggregate demand stimulus – through a net exports channel – if interest rates remained unchanged. Thus, interest rates must rise to keep output near potential and inflation near target, and the exchange rate overshoots its longer-run appreciation. While we use possible regime shift as a way of motivating why the exchange rate wouldn't likely jump to fully offset the tariff and subsidy shock, many other factors could dampen the expected appreciation of the real exchange rate in the long-run that would have similar effects as in our analysis (such as the prospect of foreign retaliation).

We compare policies that directly affect trade prices (such as IX) to alternative policies

that would have effects similar to an internal devaluation under some conditions. We find that while the import and export subsidies stimulate GDP, boost inflation, and induce domestic interest rates to rise, a combination of a higher VAT and a rise in the payroll subsidy to employers (VP policy) tends to have contractionary effect on aggregate demand and inflation, at least under a Taylor-style interest rate rule. The contractionary effects of VP are particularly large when the monetary policy reaction function is fairly unresponsive, as occurs if the central bank puts a substantial weight on exchange rate stability.

The contractionary effects of VP are due to two key assumptions. First, we assume that pre-tax prices are sticky, so that VAT increases are immediately passed through to consumer prices. Second, we assume once again that agents perceive some chance the VP policy will be reversed. The upshot is that consumers would face a higher real interest rate if policy rates were unchanged and pre-tax goods prices were also unchanged (since households would expect the prices of goods to be lower at some point in the future). Thus, policy rates would have to decline to even to keep aggregate demand (and hence output) at its pre-shock level, and the exchange rate to depreciate; since a standard Taylor rule does not provide enough accommodation to stabilize the economy, output contracts and inflation falls, and the contraction is much more severe under an exchange rate peg.

These results may seem surprising in light of Farhi et al. (2014), which show the VP provides equivalent stimulus to output and inflation as IX, at least under fixed exchange rates. The key reason for the dramatic difference in results is that we assume that consumer prices adjust quickly to the VAT – so prices are sticky in pre-tax terms – whereas Farhi et al (2014) assume that consumer prices are sticky inclusive of the VAT. We discuss some evidence in support of our specification that shows that consumer prices tend to increase quickly in response to VAT increases.[1] Nevertheless, rather than viewing this evidence as dispositive in favor of our specification of price-setting, we view our contribution as highlighting the sensitivity of equivalence results to this feature.

Finally, we also show that a border adjustment of corporate taxation is equivalent to an IX policy and, as a consequence, not to a VP policy. Intuitively, the BAT eliminates the deductibility of imports from profits, thus acting like a tariff, and exempts exports, thus

[1] See, for instance, Besley and Rosen (1999), Carbonnier (2007), and Andrade et al. (2010).

acting like an export subsidy. Consequently, BAT in general provides stimulus exactly like IX and has no allocative effects only with permanent tax changes and producer currency pricing.

The paper is organized as follows. Section 2 describes the model. Section 3 discusses conditions for equivalence of the IX, VP, and BAT policies as well as the macroeconomic effects of such policies. Section 4 concludes.

2 Model

The benchmark economy features a home (H) country and a foreign (F) country. Agents in the economy include households, retailers, producers of intermediate goods, and the government. The next sections describe the optimization problems solved by each agent. Foreign variables are denoted with an asterisk.

2.1 Households

Households in the home country derive utility from a final good consumption (C_t) and disutility from labor (N_t) . Households trade a noncontingent nominal bond (B_t) which is in zero net supply and an international bond (B_t^*). The households maximizes expected lifetime utility

$$\mathbb{E}_0 \Sigma_{t=0}^{\infty} \beta^t U\left(C_t, N_t\right) \tag{1}$$

subject to the budget constraint

$$P_t C_t + B_t + \varepsilon_t B_t^* = R_{t-1} B_{t-1} + \varepsilon_t R_{t-1}^* B_{t-1}^* + W_t N_t + \widetilde{\Pi}_t + T_t \tag{2}$$

where P_t is the consumer price index, R_{t-1} is the domestic nominal interest rate, R_t^* is the foreign nominal interest rate, ε_t is the nominal exchange rate (defined as the price of one unit of foreign currency in terms of units of home currency), W_t is the wage rate, $\widetilde{\Pi}_t$ is the aggregate profit of the home firms assumed to be owned by the home consumers, T_t is a lump-sum transfer from the government. We assume for simplicity that the period utility function is

$$U(C, N) = \frac{1}{1-\sigma} C_t^{1-\sigma} - \frac{1}{\eta+1} N_t^{1+\eta} \tag{3}$$

Optimality requires the standard conditions:

$$N_t^{\eta} C_t^{\sigma} = \frac{W_t}{P_t} \tag{4}$$

$$1 = \beta \mathbb{E}_t \left[\Lambda_{t,t+1} \frac{P_t}{P_{t+1}} R_t \right] \tag{5}$$

$$1 = \beta \mathbb{E}_t \left[\Lambda_{t,t+1} \frac{P_t}{P_{t+1}} \frac{\varepsilon_t}{\varepsilon_{t+1}} R_t^* \right] \tag{6}$$

where $\Lambda_{t,t+1} = \left(\frac{C_t}{C_{t+1}} \right)^{\sigma}$ is the real stochastic discount factor of the home household. The corresponding intertemporal optimality condition for the foreign household is

$$1 = \beta \mathbb{E}_t \left[\Lambda_{t,t+1}^* \frac{P_t^*}{P_{t+1}^*} R_t^* \right] \tag{7}$$

which, together with (6), implies the risk-sharing condition

$$\mathbb{E}_t \left\{ \left[\Lambda_{t,t+1} \frac{Q_{t+1}}{Q_t} - \Lambda_{t+1}^* \right] \right\} = 0 \tag{8}$$

where Q_t is the real exchange rate expressed as the price of the foreign consumption bundle in home currency relative to the price of the domestic consumption bundle, that is

$$Q_t = \varepsilon_t \frac{P_t^*}{P_t} \tag{9}$$

2.2 Retailers

Competitive home retailers combine home and foreign goods to produce the final good according to the constant-elasticity-of-substitution (CES) aggregator

$$C_t = \left[\omega_H^{\frac{1}{\theta}} y_{Ht}^{\frac{\theta-1}{\theta}} + (1-\omega_H)^{\frac{1}{\theta}} y_{Ft}^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \tag{10}$$

where $\theta \geq 0$ determines the elasticity of substitution between home and foreign intermediates and $\omega_H \in [0.5, 1]$ governs home bias. The home good (y_{Ht}) and the foreign good (y_{Ft}) consist of CES aggregatore over home and foreign varieties

$$y_{Ht} = \left[\int_0^1 y_{Ht}(i)^{\frac{\gamma-1}{\gamma}} di \right]^{\frac{\gamma}{\gamma-1}} \tag{11}$$

$$y_{Ft} = \left[\int_0^1 y_{Ft}(i)^{\frac{\gamma-1}{\gamma}} di\right]^{\frac{\gamma}{\gamma-1}} \tag{12}$$

Profit for the home retailers are

$$\Pi_t^R = (1-\tau_t^v)(1-\tau_t^\pi)\left\{P_t C_t - P_{Ht} y_{Ht} - \frac{P_{Ft}}{(1-\tau_t^\pi)} y_{Ft}\right\} \tag{13}$$

where τ_t^v is the value-added tax and τ_t^π is the border-adjusted tax rate on profits. The border adjustment implies that the cost of foreign goods cannot be deducted from profits. Prices are inclusive of value-added taxes and, in the case of foreign intermediates, are also inclusive of tariffs (τ_t^m).

Given the CES structure of these aggregators, the home and foreign good demand is characterized by

$$y_{Ht} = \omega\left[\frac{P_{Ht}}{P_t}\right]^{-\theta} C_t \tag{14}$$

$$y_{Ft} = (1-\omega)\left[\frac{P_{Ft}}{(1-\tau_t^\pi) P_t}\right]^{-\theta} C_t \tag{15}$$

$$y_{Ht}(i) = \left[\frac{P_{Ht}(i)}{P_{Ht}}\right]^{-\gamma} y_{Ht} \tag{16}$$

$$y_{Ft}(i) = \left[\frac{P_{Ft}(i)}{P_{Ht}}\right]^{-\gamma} y_{Ht} \tag{17}$$

The home-country price indexes consistent with the CES aggregators are

$$P_t = \left[\omega P_{Ht}^{1-\theta} + (1-\omega)\left(\frac{P_{Ft}}{1-\tau_t^\pi}\right)^{1-\theta}\right]^{\frac{1}{1-\theta}} \tag{18}$$

$$P_{Ht} = \left[\int_0^1 P_{Ht}(i)^{1-\gamma} di\right]^{\frac{1}{1-\gamma}} \tag{19}$$

$$P_{Ft} = \left[\int_0^1 P_{Ft}(i)^{1-\gamma} di\right]^{\frac{1}{1-\gamma}} \tag{20}$$

2.3 Producers

Each country features a continuum $i \in [0,1]$ of monopolistically-competitive firms producing different varieties of intermediate goods. Producers use the technology

$$Y_{Ht}^{*}(i) = A_t Z_t(i) N_t^{\alpha}(i) \tag{21}$$

with $0 < \alpha \leq 1$. A_t is the aggregate country-wide level of technology and $Z_t(i)$ is the idiosyncratic level of technology. Producers use labor $N(i)$ as the only input of production. Total production is sold both domestically and abroad

$$y_{Ht}(i) + y_{Ht}^{*}(i) = Y_{Ht}(i) \tag{22}$$

at price $P_{Ht}(i)$ and $P_{Ht}^{*}(i)$, respectively. Profits of the firm i are

$$\Pi_t^i = (1 - \tau_t^{\pi})\,\Pi_t^{i,\pi} + (1 + \varsigma_t^x)\,\varepsilon_t P_{Ht}^{*}(i) y_{Ht}^{*}(i) \tag{23}$$

$$\Pi_t^{i,\pi} = \left[(1 - \tau_t^v)\,P_{Ht}(i) y_{Ht}(i) - (1 - \varsigma_t^v)\,W_t N_t(i)\right] \tag{24}$$

where $\Pi_t^{i,\pi}$ are profits taxed under the border-adjusted corporate tax (that is, total domestic sales reduced by the total labor costs), ς_t^v is the payroll subsidiy, and ς_t^x is the export subsidy. This expression indicates that export sales are not subject to the border-adjusted tax on corporate profits and the value-added tax.

Aggregate profits of the home firms are given by

$$\widetilde{\Pi}_t = \int_0^1 \Pi_t^i di \tag{25}$$

Aggregate profits subject to the border-adjusted corporate tax are

$$\widetilde{\Pi}_t^{\pi} = \int_0^1 \Pi_t^{i,\pi} di \tag{26}$$

Aggregate labor demand is

$$N_t = \int_0^1 N_t(i)\,di \tag{27}$$

Firm i sets prices as in Calvo (1983): In any given period, it can adjust its price with probability $(1 - \zeta_P)$ and maintains the same price as in the previous period with probability ζ_P. We assume that, absent any price adjustment by the firm, fluctuations in VAT taxes

are fully passed through to the consumer. This implies that firm $i's$ price inclusive of VAT evolves according to:

$$P_{Ht}(i) = \begin{cases} \overline{P}_{Ht}(i) & \text{w/prob } (1-\zeta_P) \\ P_{Ht-1}\frac{(1-\tau^v_{t-1})}{(1-\tau^v_t)} & \text{w/prob } \zeta_P \end{cases} \tag{28}$$

Given production technology (21) and good demand by retailers in the home market (16) and, similarly, the foreign market, firm i chooses prices to maximize the expected present discounted value of profits conditional on no price change

$$\mathbb{E}_t \Sigma^{\infty}_{s=t} \zeta_P^{s-t} \left[\Lambda_{s,t} \Pi^i_s\right] \tag{29}$$

The benchmark model considers two price-setting strategies in terms of currency, namely producer currency pricing (PCP) and local currency pricing (LCP).

Producer Currency Pricing. Under PCP, home firm i sets price $\overline{P}_{Ht}(i)$ in the home currency, while the price for the foreign market satisfies the law of one price

$$P^*_{Ht}(i) = \frac{(1-\tau^{\pi}_t)(1-\tau^v_t)}{(1+\varsigma^x_t)} \frac{P_{Ht}(i)}{\varepsilon_t} \tag{30}$$

Thus, under PCP, home firms set a single price in their domestic currencies for both domestic and foreign markets, letting the exchange rate and taxes fully pass through. The reset price $\overline{P}_{Ht}(i)$ satisfies the following optimality condition

$$\mathbb{E}_t \Sigma^{\infty}_{s=t} \zeta_P^{s-t} \Lambda_{s,t} Y_{Ht}(i) P_{Hs} (1-\tau^{\pi}_s) \left[\overline{P}_{Ht}(i)(1-\tau^v_t) - (1-\varsigma^v_s)\frac{\gamma}{\gamma-1}\frac{W_s}{\alpha A_s Z_s(i) N_s(i)^{\alpha-1}}\right] = 0 \tag{31}$$

Expression (31) indicates that the adjusted price $\overline{P}_{Ht}(i)$ is a constant markup over the weigthed-average expected future marginal costs during the period for which the price will be in effect.

Similarly, foreign firm j sets price $\overline{P}^*_{Ft}(j)$ in the foreign currency, letting the price for the home market satisfy the law of one price

$$P_{Ft}(j) = \frac{(1+\tau^m_t)}{(1-\tau^v_t)} P^*_{Ft}(j) \varepsilon_t \tag{32}$$

where the optimal choice of $P_{Ft}^{*}(i)$ satisfies

$$\mathbb{E}_t \Sigma_{s=t}^{\infty} \zeta_P^{*s-t} \Lambda_{s,t}^{*} Y_{Ft}^{*}(j) P_{Fs}^{*} \left[\overline{P}_{Ft}^{*}(j) - \frac{\gamma}{\gamma - 1} \frac{W_s^{*}}{\alpha A_s^{*} Z_s^{*}(i)^{*} N_s^{*}(j)^{\alpha - 1}} \right] = 0 \tag{33}$$

Using the evolution of firm $i's$ price in (28) in the P_H price index equation (19) and using the law of large numbers we derive a forward-looking Phillips curve for domestic price inflation

$$\pi_{Ht} = \left[\zeta_P \left(\frac{\left(1 - \tau_{t-1}^{v}\right)}{\left(1 - \tau_t^{v}\right)} \right)^{1-\gamma} + (1 - \zeta_P) \left(\frac{\bar{P}_{H,t}}{P_{H,t-1}} \right)^{1-\gamma} \right]^{\frac{1}{1-\gamma}} \tag{34}$$

that relates domestic inflation, π_{Ht}, to future marginal costs through the optimal reset price $\bar{P}_{H,t}$. This expression reveals that, in the presence of nominal price rigidities ($\zeta_P > 0$), a VAT increase translates directly into higher domestic price inflation because of our assumption of full pass through of taxes.

Local Currency Pricing. Under LCP, home firm i sets the home-market price $\overline{P}_{Ht}(i)$ in the home currency and the foreign-market price $\overline{P}_{Ht}^{*}(i)$ in foreign currency. This pricing assumption implies that, during periods of non-adjustment, fluctuations in the nominal exchange rate and taxes creates fluctuations in the relative price of the firm across the home and foreign market. Consequently, the law of one price is violated. Profit maximization with respect to the two markets implies that $\overline{P}_{Ht}(i)$ and $\overline{P}_{Ht}^{*}(i)$ satisfy the following optimality conditions

$$\mathbb{E}_t \Sigma_{s=t}^{\infty} \zeta_P^{s-t} \Lambda_{s,t} y_{Ht}(i) P_{Hs} \left(1 - \tau_s^{\pi}\right) \left[\overline{P}_{Ht}(i) \left(1 - \tau_t^{v}\right) - \left(1 - \varsigma_s^{v}\right) \frac{\gamma}{\gamma - 1} \frac{W_s}{\alpha A_s Z_s(i) N_s(i)^{\alpha - 1}} \right] \tag{35}$$

$$\mathbb{E}_t \Sigma_{s=t}^{\infty} \zeta_P^{s-t} \Lambda_{s,t} y_{Ht}^{*}(i) P_{Hs}^{*} \left[\frac{(1 + \varsigma_s^{x})}{(1 - \tau_s^{\pi})} \varepsilon_s \overline{P}_{Ht}^{*}(i) - \left(1 - \varsigma_s^{v}\right) \frac{\gamma}{\gamma - 1} \frac{W_s}{\alpha A_s Z_s(i) N_s(i)^{\alpha - 1}} \right] \tag{36}$$

Similarly, foreign firm j sets price $\overline{P}_{Ft}^{*}(j)$ in the foreign currency and $\overline{P}_{Ft}(j)$ in the home currency so that the following optimality conditions are satisfied

$$\mathbb{E}_t \Sigma_{s=t}^{\infty} \zeta_P^{*s-t} \Lambda_{s,t}^{*} y_{Ft}^{*}(j) P_{Fs}^{*} \left[\overline{P}_{Ft}^{*}(j) - \frac{\gamma}{\gamma - 1} \frac{W_s^{*}}{\alpha A_s^{*} Z_s^{*}(j) N_s^{*}(i)^{\alpha - 1}} \right] \tag{37}$$

$$\mathbb{E}_t \Sigma_{s=t}^{\infty} \zeta_P^{*s-t} \Lambda_{s,t}^{*} y_{Ft}(j) P_{Fs}^{*} \left[\frac{(1 - \tau_s^{v})}{(1 + \tau_s^{m})} \frac{\overline{P}_{Ft}(j)}{\varepsilon_s} - \frac{\gamma}{\gamma - 1} \frac{W_s^{*}}{\alpha A_s^{*} Z_s^{*}(j) N_s^{*}(j)^{\alpha - 1}} \right] \tag{38}$$

2.4 Fiscal and Monetary Policy

The government sets tax policy exogenously according to the rules

$$\tau_t^m = \varsigma_t^x = \delta_t \tag{IX}$$

$$\tau_t^\pi = \frac{\delta_t}{1+\delta_t} \tag{BAT}$$

$$\tau_t^v = \varsigma_t^v = \frac{\delta_t}{1+\delta_t} \tag{VAT}$$

where $\delta_t \in \{0, \delta\}$ is a two-state Markov chain with $\delta_0 = \delta$ and transition matrix

$$\Omega = \begin{bmatrix} \rho & 1-\rho \\ 0 & 1 \end{bmatrix} \tag{39}$$

The parameter ρ governs the persistence of the tax policies and $\delta_t = 0$ represents an absorbing state. The government budget constraint is

$$\tau_t^m \varepsilon_t P_{F,t}^* - \varsigma_t^x \varepsilon_t P_{H,t}^* + \frac{\tau_t^p}{1+\tau_t^p}\widetilde{\Pi}_t^\pi + \frac{\tau_t^v}{1+\tau_t^v} P_{F,t}^* - \frac{\varsigma_t^v}{1+\varsigma_t^v} W_t N_t = T_t \tag{40}$$

Monetary policy in the home country follows the interest rate rule

$$R_t = \frac{1}{\beta}\left(\pi_{Ht}\frac{(1-\tau_t^v)}{\left(1-\tau_{t-1}^v\right)}\right)^{\varphi_\pi}(\tilde{y}_t)^{\varphi_y}\left(\varepsilon_t - \bar{\varepsilon}_t\right)^{\varphi_\varepsilon} \tag{41}$$

where φ_π is the weight on domestic price inflation (π_{Ht}) and φ_y is the weight on the output gap ($\tilde{y}_t$). The parameter $\varphi_\varepsilon \in \{0, M\}$ governs the sensitivity of the interest rate rule to changes in the nominal exchange rate.[2] When $\varphi_\varepsilon = 0$, the home interest rate responds exclusively to fluctuations in domestic inflation and output gaps. When $\varphi_\varepsilon = M$, the home interest rate rule proactively responds to deviations of the nominal exchange rate from a target exchange rate.

The government budget constraint (40), the household budget constraint (2), and the definition of profits imply the aggregate budget constraint for the home country

$$\varepsilon_t B_t^* = \varepsilon_t B_{t-1}^* R_{t-1}^* + NX_t \tag{42}$$

where

$$NX_t = P_{Ht}^* y_{Ht}^* \varepsilon_t - \frac{(1-\tau_t^v)}{(1+\tau_t^m)} P_{Ft} y_{Ft} \tag{43}$$

[2] See Benigno *et al.* (2007) for a discussion of interest rate rules that maintain a fixed exchange rate.

The terms of trade (S_t) are the price of exports relative to the price of imports

$$S_t = \frac{P^*_{Ht}}{P_{Ft}} \frac{\varepsilon_t \left(1 + \tau^m_t\right)}{\left(1 - \tau^v_t\right)} \tag{44}$$

3 Macroeconomic Effects of Trade Policy

We begin our analysis of the effects of IX, BAT, and VP by focusing on the special case of permanent policy changes under producer currency pricing and flexible exchange rates. Under these assumptions, the three policies are equivalent and neutral as the real exchange rate appreciate just enough to completely offset any stimulative effect of these policies on net exports and output. The appreciation of the real exchange rate, however, originates from different sources, namely an immediate jump in the nominal exchange rate under IX or BAT, and an adjustment in the domestic price level under VP. A direct implication of this observation is that when we consider the case of fixed nominal exchange rates, the policies are not equivalent anymore. In this case IX and BAT act like a fiscal devaluation and stimulate output, while VP remains neutral.

We next turn our attention to the more general case of transitory policy changes. Here we show that, for IX and BAT, the same qualitative effects of a permanent change under PCP that materialize under a fixed exchange rate regime extend to both fixed and variable exchange rate regimes and arbitrary pricing conventions (PCP or LCP). IX and BAT are always equivalent, they stimulate net exports and domestic output, and reduce foreign output. These policies appreciate the real exchange rate but this only partially offsets the stimulative effects on output and net exports. VP is not equivalent to IX or BAT, however. With a significant level of nominal price rigidity or under fixed exchange rates, VP is contractionary even in the home country.

3.1 A special case : a permanent change under PCP

We start by considering the case in which monetary policy targets domestic price inflation and the output gap, while exchange rates are perfectly flexible:

$$R_t = \frac{1}{\beta} \left(\pi_{Ht} \frac{\left(1 - \tau^v_t\right)}{\left(1 - \tau^v_{t-1}\right)} \right)^{\varphi_\pi} \left(\tilde{y}_t\right)^{\varphi_y}$$

In this case we can state the following proposition.

Proposition 1. *If the exchange rate regime is flexible, $\varphi_\varepsilon = 0$, and prices are set in producer currency, a permanent unexpected IX policy*

$$IX = \{\tau_s^m, \varsigma_s^x\}_{s\geq t} \quad s.t. \quad \tau_s^m = \varsigma_s^x = \delta \tag{45}$$

a permanent unexpected BAT policy

$$BAT = \{\tau_s^\pi\}_{s\geq t} \quad s.t. \quad \tau_s^\pi = \frac{\delta}{1+\delta} \tag{46}$$

and a permanent unexpected VP policy

$$VP = \{\tau_s^v, \varsigma_s^v\}_{s\geq t} \quad s.t. \quad \tau_s^v = \varsigma_s^v = \frac{\delta}{1+\delta} \tag{47}$$

have no effect on the real allocaticon and induce a real exchange rate appreciation of size $\frac{\delta}{1+\delta}$.

Appendix 1a contains the complete proof of Proposition 1. Here we explain the intuition behind equivalence and neutrality of IX and VP[3]. Assume that firms' prices relative to aggregate price indexes as well as home and foreign consumption (C_t and C_t^*) are unaffected by the policy changes. Then consider the direct effects of these policies on the supply of home and foreign exports by analyzing their impact on the two laws of one price

$$\frac{P_{Ht}^*}{P_t^*} = \frac{(1-\tau^v)}{(1+\varsigma^x)}\frac{P_{Ht}}{P_t}\frac{P_t}{\varepsilon_t P_t^*} = \frac{(1-\tau^v)}{(1+\varsigma^x)}\frac{P_{Ht}}{P_t}\frac{1}{Q_t} \tag{48}$$

$$\frac{P_{Ft}}{P_t} = \frac{(1+\tau^m)}{(1-\tau^v)}\frac{P_{Ft}^*}{P_t^*}Q_t \tag{49}$$

Absent a general equilibrium response of the real exchange rate Q_t, both IX and VP induce an expansion of domestic exports and a contraction of domestic imports as the VAT increase acts like an import tax and the VAT deductibility of exports acts as an export subsidy.

Figure 1a depicts this partial equilibrium response to IX and VP in the market for domestic exports and domestic imports, y_H^* and y_F, assuming that all other markets are

[3] As shown in Section 3.2, IX and BAT are always equivalent in our environment. Hence, we decided to simplify notation and focus on the relation between IX and VP here.

unaffected by the policies:

$$\left(\frac{Y_{H,t}^*}{(1-\omega^*)\,C_t^*}\right)^{-\theta} = \frac{P_{Ht}^*}{P_t^*} = \frac{(1-\tau^v)}{(1+\varsigma^x)}\frac{P_{Ht}}{P_t}\frac{1}{Q_t} \tag{50}$$

$$\left(\frac{Y_{F,t}}{(1-\omega)\,C_t}\right)^{-\theta} = \frac{P_{Ft}}{P_t} = \frac{(1+\tau^m)}{(1-\tau^v)}\frac{P_{Ft}^*}{P_t^*}Q_t \tag{51}$$

The tax changes cause an increase in the home price for imports, thus decreasing import demand (left panel), and a reduction in export prices that increases the demand of home exports. Thus, the partial equilibrium effect of these polcies is to generate a trade surplus.

We next study the general equilibrium response of the home-country savings and real exchange rate. Combining (50) and (51) in (43) , we obtain the expression

$$NX_t^*\left(Q_t;\tau_t^m,\varsigma_t^x,\tau_t^v\right) = \frac{P_{Ht}^*}{P_t^*}y_{Ht}^* - \frac{(1-\tau_t^v)}{(1+\tau_t^m)}\frac{1}{Q_t}\frac{P_{Ft}}{P_t}y_{Ft} \tag{52}$$

which determines the partial response of net exports to variations in the real exchange rate and policies. As it is clear from (50) and (51) , this function satisfies

$$NX_t^*\left(Q_t;\tau^m,\varsigma^x,\tau^v\right) = NX_t^*\left(Q_t\left(1+\tau^m\right);0,0,\tau^v\right) = NX_t^*\left(\frac{Q_t}{(1-\tau^v)};\tau^m,\varsigma^x,0\right) \tag{53}$$

that is, the IX and VP policies in the Proposition cause this curve to shift out by the same magnitude $(1+\tau^m) = (1+\delta) = \frac{1}{1-\tau^v}$.

To determine the general equilibrium response of the real exchange rate we turn to the market clearing conditions for domestic savings, (42) , which we rewrite in real (foreign good) terms as:

$$S\left(Q_t\right) = \frac{\left[B_t^* - B_{t-1}^*R_{t-1}^*\right]}{P_t^*} = NX^*\left(Q_t\right) \tag{54}$$

Equation (54) equates the home country supply of savings to the foreign country demand for borrowing, which is equal to home net exports.

The condition determining domestic savings is the optimality condition for holdings of the foreign bond (8)

$$\mathbb{E}_t\left\{\left[\Lambda_{t,t+1}\frac{Q_{t+1}}{Q_t} - \Lambda_{t+1}^*\right]\right\} = 0 \tag{55}$$

which shows that an appreciation of the real exchange rate at $t+1$, i.e. a decrease in Q_{t+1}, amounts to a decrease in the real interest rate offered by the foreign country for intertemporal

savings and hence reduces the home supply of savings. Figure 1b shows how the shift in home saving supply associated with a higher expected real exchange rate offsets the expansion of net exports induced by IX and VP. In particular, when the policy changes are expected to be permanent, both Q_{t+1} and Q_t increase by $\frac{\delta}{1+\delta}$, which implies that the offset is complete leaving the allocation at the original equilibrium. See Figure 1c.

To complete the argument, we need to verify that all other optimality conditions are indeed unaffected by the permanent change in the fiscal instruments and in the real exchange rate. It is immediate to verify that, under IX, no other equilibrium condition is affected and the adjustment in the real exchange rate is achieved by a nominal appreciation of size $\frac{1+\delta}{\delta}$, that is

$$Q_t^{IX} = \frac{1+\delta}{\delta} Q_t = \varepsilon_t^{IX} \frac{P_t^*}{P_t}$$

In the case of VP, in contrast, the tax changes affect two additional equilibrium conditions. First, the optimality condition of the home firm i requires that a VAT increase is accompanied by a payroll subsidy in order to prevent any distortion in the supply of the home varieties

$$\mathbb{E}_t \Sigma_{s=t}^{\infty} \zeta_P^{s-t} \Lambda_{s,t} Y_{Ht}(i) P_{Hs} (1-\tau^{\pi}) \left[\overline{P}_{Ht}(i) (1-\tau^v) - (1-\varsigma^v) \frac{\gamma}{\gamma-1} \frac{W_s}{\alpha A N_s(i)^{\alpha-1}} \right] = 0 \quad (56)$$

Intuitively, the VAT increase reduces the firm's marginal revenue, $\overline{P}_{Ht}(i)(1-\tau^v)$, for any given price $\overline{P}_{Ht}(i)$ paid by the consumer. Payroll subsidies (ς^v) ensure that this reduction in marginal revenues is offset by an equal reduction in marginal costs .

Second , under our assumption that VAT taxes are fully passed through to the consumer, the Phillips curve for domestic price inflation

$$\pi_{Ht} = \left[\zeta_P \left(\frac{(1-\tau_{t-1}^v)}{(1-\tau_t^v)} \right)^{1-\gamma} + (1-\zeta_P) \left(\frac{\bar{P}_{H,t}}{P_{H,t-1}} \right)^{1-\gamma} \right]^{\frac{1}{1-\gamma}} \quad (57)$$

indicates that a VAT increase boosts domestic price inflation π_{Ht}. Given our assumption that monetary policy policy sees through any increase in domestic price inflation due to VAT changes, neutrality of VP follows by letting all prices under VP increase by $\frac{1}{1-\tau_t^v} = \frac{\delta}{1+\delta}$

$$P_{H,t}^{VP} = \frac{P_{H,t}^{IX}}{1-\tau_t^v}; \quad P_{F,t}^{VP} = \frac{P_{F,t}^{IX}}{1-\tau_t^v}; \quad P_t^{VP} = \frac{P_t^{IX}}{1-\tau_t^v}$$

In other words, under VP the real exchange rate appreciation is achieved through an adjustment in the price level

$$Q_t^{VP} = \frac{1+\delta}{\delta} Q_t = \varepsilon_t \frac{P_t^*}{P_t^{VP}}$$

The different response of inflation and the nominal exchange rate under IX and VP in a flexible exchange rate regime is key to understand the response of the economy when the nominal exchange rate is fixed. In a fixed exchange rate regime, IX (and BAT) will in general stimulate net exports and output as the inability of the nominal exchange rate to appreciate does not allow the real exchange rate to fully offset the net export stimulus of the policy. Indeed, IX (and BAT) in this case will implement the same allocation of a currency devaluation as conjectured by Keynes and formalized in the fiscal devaluation literature.[4] VP, in contrast, remains neutral irrespective of the monetary policy regime as the nominal exchange rate is constant even under a flexible exchange rate regime. The proposition below formally states this result. The proof is in the Appendix.

Proposition 2. *If the exchange rate regime is fixed, $\varphi_\varepsilon = M$, and prices are set in producer currency, a permanent unexpected IX policy*

$$IX = \{\tau_s^m, \varsigma_s^x\}_{s \geq t} \quad s.t. \quad \tau_s^m = \varsigma_s^x = \delta \tag{58}$$

and a permanent unexpected BAT policy

$$BAT = \{\tau_s^\pi\}_{s \geq t} \quad s.t. \quad \tau_s^\pi = \frac{\delta}{1+\delta} \tag{59}$$

have the same allocative effects of a once and for all unexpected currency devaluation of size δ. A *permanent unexpected VP policy of the same size*

$$VP = \{\tau_s^v, \varsigma_s^v\}_{s \geq t} \quad s.t. \quad \tau_s^v = \varsigma_s^v = \frac{\delta}{1+\delta} \tag{60}$$

has no effect on the real allocaticon.

3.2 The general case

In this section we move to the case in which the fiscal adjustments are perceived to be transitory. We show that the equivalence between IX and BAT generalizes to transitory

[4] See Farhi et al (2014).

changes and arbitrary price settting conventions (i.e. PCP, LCP). In contrast, with nominal rigidities, relaxing any of the assumptions in Proposition 1 will result in different allocative effects of VP and the other two policies. The proposition below states this result formally:

Proposition 3. *Under full pass-through of taxes, the policies*

$$IX = \{\tau_s^m, \varsigma_s^x\}_{s\geq t} \quad s.t. \quad \tau_s^m = \varsigma_s^x = \delta_s \tag{61}$$

and

$$BAT = \{\tau_s^\pi\}_{s\geq t} \quad s.t. \quad \tau_s^\pi = \frac{\delta_s}{1+\delta_s} \tag{62}$$

implement the same allocation. Generically, the policy

$$VP = \{\tau_s^v, \varsigma_s^v\}_{s\geq t} \quad s.t. \quad \tau_s^v = \varsigma_s^v = \frac{\delta_s}{1+\delta_s} \tag{63}$$

does not implent the same allocation as IX or BAT. The three policies are equivalent only if prices are flexible or when the change is permanent and firms set prices in producer currency (See Proposition 1).

Appendix A.1 presents a formal proof of Proposition 1. The intuition for the equivalence of IX and BAT can be summarized by the observation that the non-deductibility of imports acts like an impot tariff whereas the exemption of export sales acts like an export subsidy. Nonetheless, this observation is not sufficient as the IX and BAT policies appear to distort, respectively, the supply and demand of foreign good in the home country. The assumption of full pass through of import taxes ensures that the supply shift under IX is exactly symmetric to the demand shift under BAT, regardles of the specific pricing convention.[5] Therefore, the allocation under BAT will be identical to the allolcation under IX with the only difference that import prices will be lower under BAT:

$$\frac{P_{Fs}^{BAT}}{(1-\tau_s^\pi)} = P_{Fs}^{BAT}(1+\tau_t^m) = P_{Fs}^{IX}$$

The intution for the lack of equivalence between VP and IX (or BAT) is based on the same argument that lead to lack of equivalence in Proposition 2 above. Under VP, and given our assumption of full pass through of VAT taxes, the slow response of domestic producers

[5] If import tariffs are not fully passed through, as for example in Farhi et al (2013), BAT and IX would not be equivalent under LCP.

in adjusting (pre-tax) prices leads to an increase in consumer prices of the domestic good at home, $P_{H,t}$. This increase will depress domestic demand of the home variety and limit the competitiveness boost coming from deductibility of exports from VAT taxes.

We now turn to the simulations of the effects of IX and VP. We start by showing that neutrality of IX (and BAT) is a very fragile result. Once we assume that agents believe that the policy will be eventually reversed, $\rho = .95$,[6] IX (and BAT) are stimulative regardless of the monetary policy regime. The exchange rate offset is still operative under a flexible exchange rate regime, but it does not completely offset the stimulative effects of the policy. Figure 2 shows the resppnse of the economy to a uniform increase in import tariffs and export subsidies of 10 percentage points.

The solid line portrays the response of the economy with flexible prices, $\zeta_P = 0$, and variable exchange rates. Even in the flex price economy, the transitory nature of the fiscal adjustment implies that the real exchange rate offset is not complete. This can be understood by going through Figures 1a-c and noticing that as long as the real exchange rate is expected to eventually revert to its long run level, the reduction in home saving supply associated to an appreciated real exchange rate in the future will fall short of completely offsetting the shifting out of the net export curve. Therefore the policy stimulates home exports and contracts foreign imports.

At fixed (pre-tax) prices, the rise in the price of domestic imports leads consumers to switch towards home produced goods. In a flex price economy, however, firms immediately increase prices of domestic goods at home to reflect higher resource pressure induced by the boost in exports. This results in tighter policy rates and depressed domestic demand for the home good, Y_H.

The effects on the foreign economy are exactly symmetric: foreign consumsption of the foreign good rises sligthly and foreign output contracts, dragged down by foreign exports (home imports).

The effects in the sticky price economy are qualitatively similar with the main exception of the response in the domestic market for the home good. When prices are sticky, firms are unable to raise their prices enough to offset the demand switching of home consumers towards

[6] Say something about retaliation.

domestic goods. Domestic inlfation rises by less, the policy rate is lower and consumtpion of the home good is practically unaffected by the policy: the effects of tighter nominal rates on aggregate demand offsets the relative increase in the demand of domestic good. The lower rise in domestic prices together with the smaller increase in the real exchange rate, translates into a bigger decrease in export prices and a larger boom in exports and output. Symmetric arguments again apply to the effect of sticky prices on the response of the foreign economy that experiences a smaller decrease in inflation and a larger drop in output.

Finally, the dashed dotted line shows the response of the sticky price economy when the nominal exchange rate is fixed. In this case, firms inability to raise prices is coupled with a monetary policy that imports the expansionary stance of the foreign economy in order to keep nominal rates fixed. The result is a much smaller increase in the real exchange rate, as now both prices and nominal exchange rates are not allowed to vary flexibly, and a large boom in both domestic consumption of the home good and domestic exports.

Finally, Figure 3 shows the same exercise with a VAT cum payroll increase of $\frac{.1}{1+.1}$. Again, we can focus on the domestic market for the home good to understand the differences between IX and VP. Under VP, when domestic fimrs are unable to freely adjust prices, the VAT tax is fully passed through to consumers causing a big jump in CPI inflation. This results in a sizeable drop in the home consumption of the domestic good, Y_H, and a smaller boost to net exports associated with higher export prices and smaller relative increase in import prices. When prices are rigid enough, this can cause output to actually contract in response to VP.

4 Conclusion

TBA

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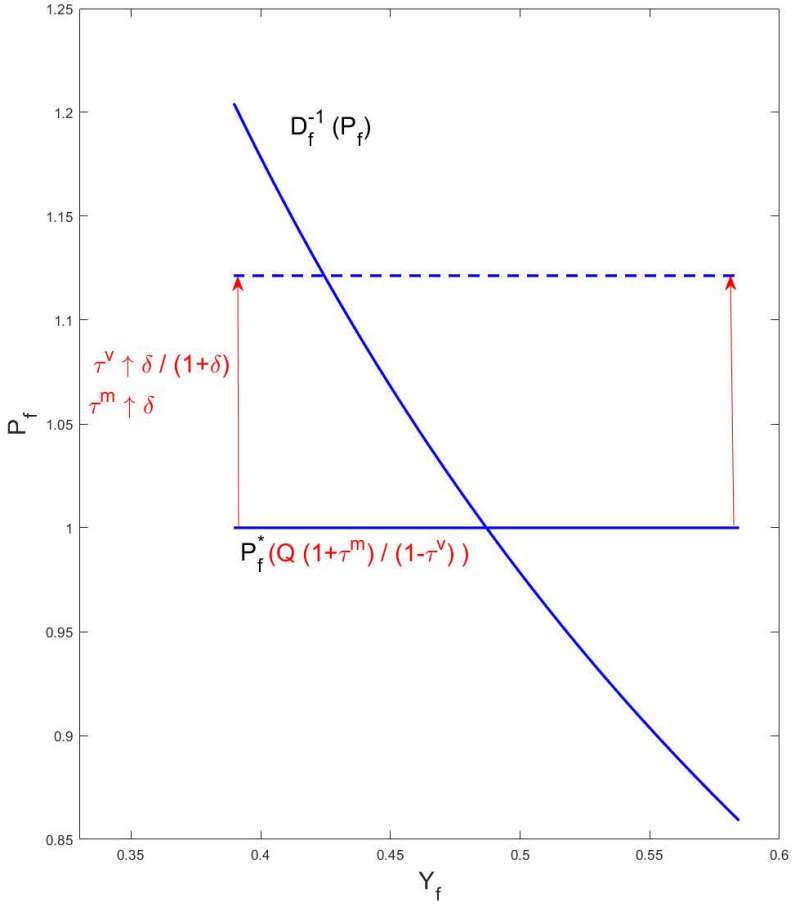
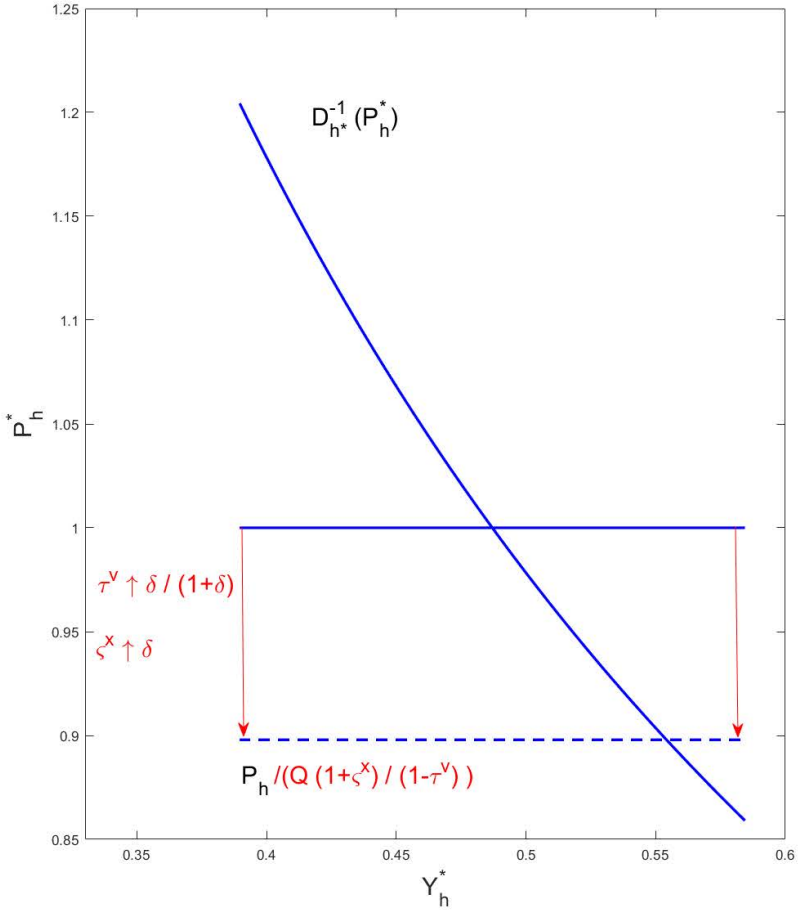
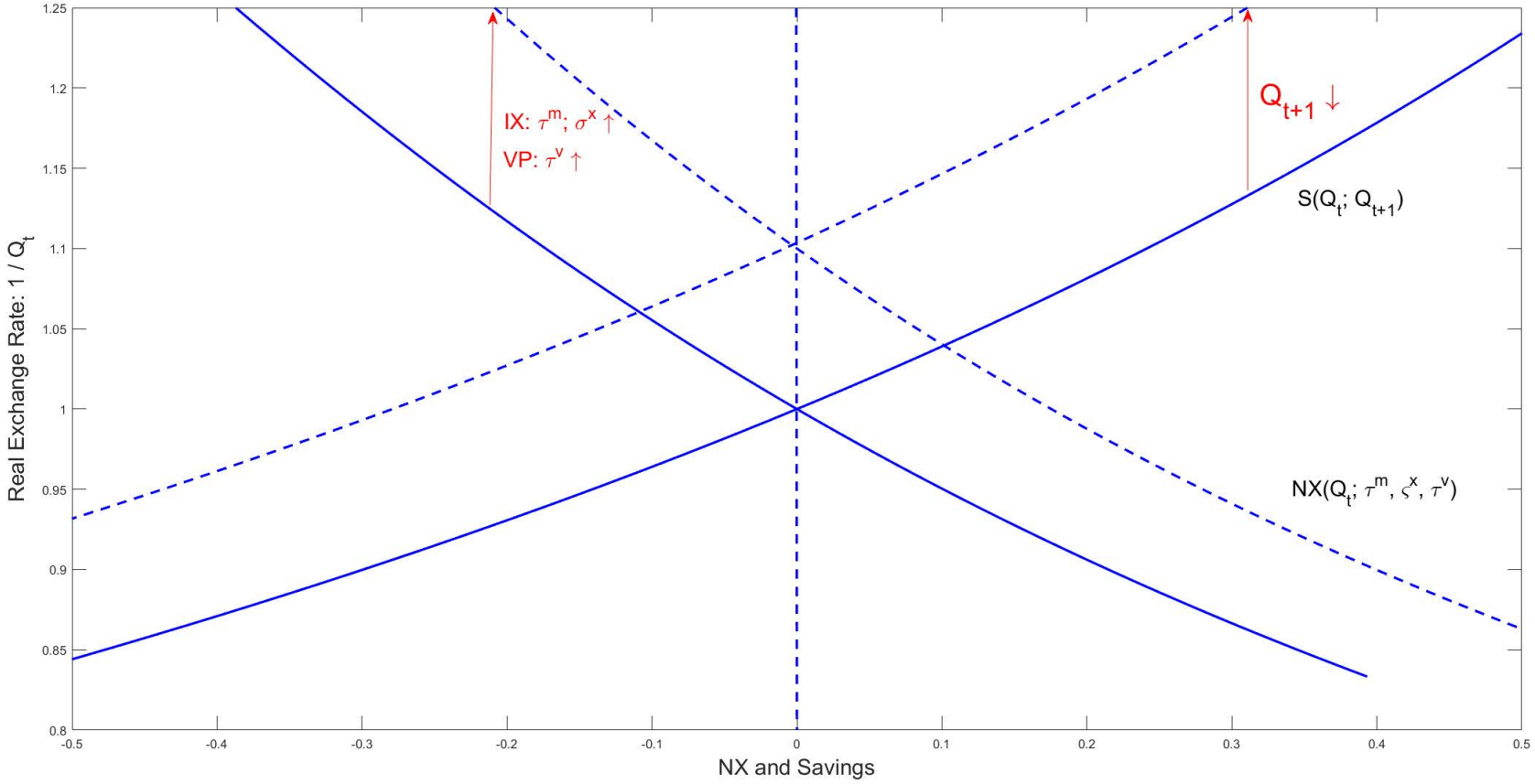
Supply Effects of IX and VP of Size δ
Partial Equilibrium: Fixed RER

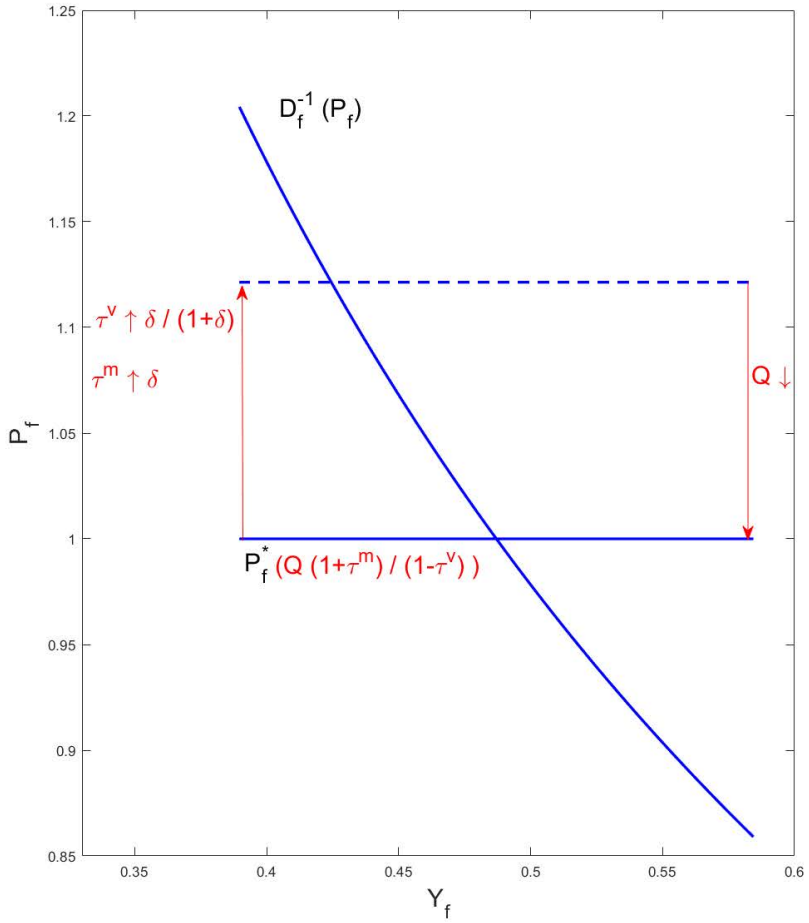


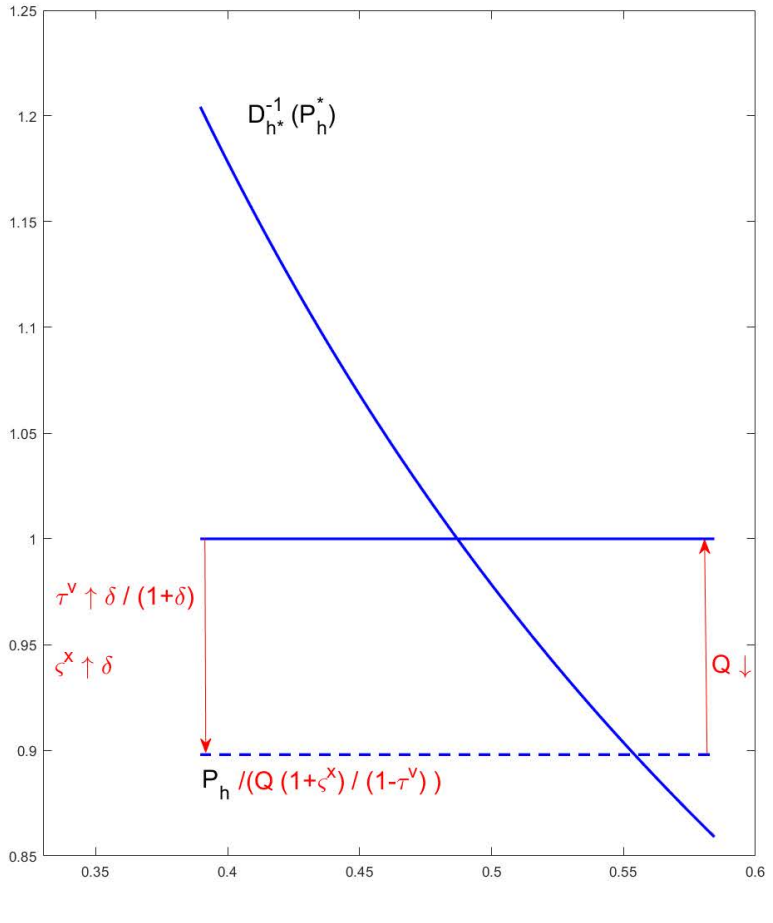


Exchange Rate Determination: Trade Balance

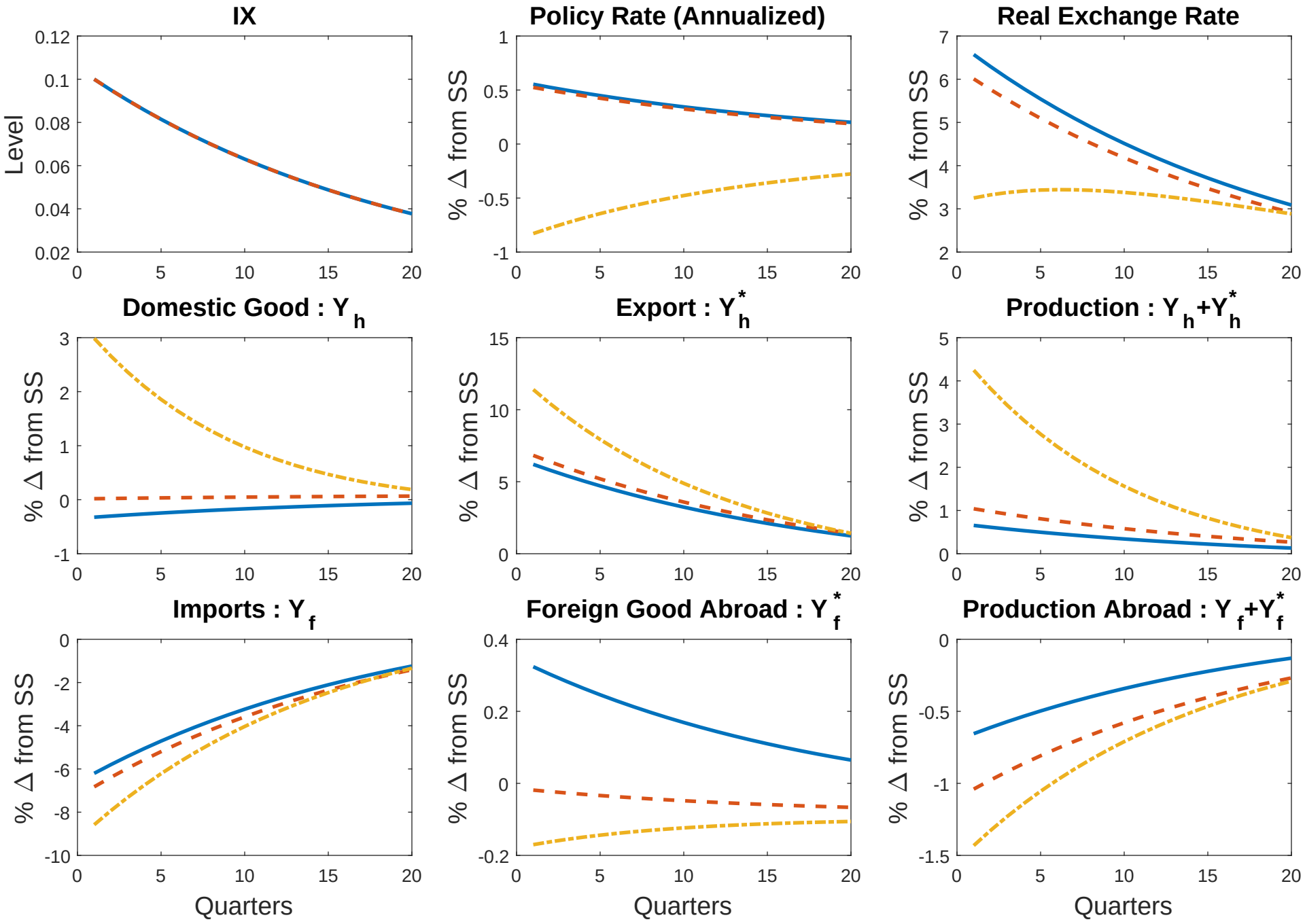


Complete Exchange Rate Offset





Import Tariff and Export Subsidy Under Flexible and Fixed Exchange Rates



VP vs IX Calvo Rigidities (PCP)