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Trade Policies and Fiscal Devaluations[†]

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Fiscal devaluations—an increase in import tariffs and export subsidies (IX) or an increase in value-added taxes and payroll subsidies (VP)—have been shown to provide as much stimulus under fixed exchange rates as a currency devaluation. We find that if agents expect policies to be reversed and the tax pass-through is large, VP is contractionary and IX provides a modest boost. In our medium-scale DSGE model, both features are crucial in accounting for Germany's underperformance in response to VP in 2007. These findings cast doubt on fiscal devaluations as a cyclical stabilization tool when monetary policy is constrained. (*JEL* E32, E52, E62, F13, F33, H20)

There is a long-standing debate about how trade and fiscal policies can provide macroeconomic stimulus by boosting international competitiveness. In considering different ways of alleviating a deep economic recession within the confines of the gold standard, Keynes argued that the United Kingdom could derive a similar degree of stimulus from raising import tariffs and providing export subsidies as through devaluing the pound against gold.[1] However, even if these policies can provide stimulus under fixed exchange rates, it is unclear to what extent they would do so under flexible exchange rates. Mundell (1961) questioned whether the mercantilist prescription of higher import tariffs and export subsidies would stimulate demand in economies with floating exchange rates, as "equilibrium in the balance of payments is automatically maintained by variations in the price of foreign exchange."

More recently, there has been renewed interest in the question of how countries constrained by membership in a currency union can implement changes in tax instruments with economic effects akin to a currency depreciation. The approach of

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[1]See Macmilan et al. (1931). Eichengreen (1981) provides an account of the contentious political debate that preceded the United Kingdom's shift toward protectionist trade policies in the early 1930s.

financing competitiveness-enhancing payroll tax cuts with VAT increases, in particular, has a strong intuitive appeal and has received attention by both academics and policymakers.[2] In a seminal contribution, Farhi, Gopinath, and Itskhoki (2014)—henceforth, FGI—provide conditions so that, under fixed exchange rates, fiscal devaluations implemented via either uniform import tariffs and export subsidies (IX policy) or a reduction in employer payroll taxes financed by an increase in VAT rates (VP policy) reproduce the same allocation as an exchange rate devaluation. Although these policies may need to be supplemented by additional tax instruments, these authors show in a quantitative application that a simple VP policy in Spain would have boosted economic activity significantly during the Great Recession. Some euro-area governments have attempted to provide macroeconomic stimulus by implementing policies akin to "fiscal devaluations," including the government of Germany in 2007.

In this paper, we make three contributions to the understanding of these important academic and policy issues by studying IX and VP policies in a New Keynesian open-economy framework that builds on contributions by Galí and Monacelli (2005) and Corsetti, Dedola, and Leduc (2010). First, we show that the transmission of IX and VP policies hinges critically on the degree of pass-through of taxes. Indeed, in a special case often considered in the literature, under our preferred assumption of full pass-through of taxes, IX implements a currency devaluation in a fixed exchange rate regime, whereas VP turns out to have *no allocative effects*. Second, we study how the effects of these policies depend on agents expectations about their persistence. Temporary IX policies tend to boost output *even under flexible exchange rates*. The macroeconomic effects of temporary VP, instead, depend on the relative strength of two offsetting channels. On the one hand, intertemporal substitution effects make VP contractionary; on the other hand, sluggish wage adjustments allow payroll subsidies to boost aggregate supply and output. We find that the first channel can easily dominate and that the contractionary effects of VP are larger when monetary policy is constrained (e.g., under an exchange rate peg or in a currency union). Third, we assess the empirical relevance of our theoretical predictions by studying the effects of the German fiscal reform in 2007 during which payroll taxes were lowered and VAT taxes increased by similar amounts. We find that a quantitative version of our model can account for the weak GDP response of the German economy to this VP policy. In a counterfactual experiment, we also show that a temporary IX policy would have caused a much smaller output boost than an exchange rate devaluation. Hence, with VP likely to be contractionary and IX providing only a modest boost, our quantitative results suggest that neither policy can be considered as a substitute for countercyclical monetary policy under flexible exchange rates.

To highlight our theoretical contribution, we begin by illustrating the different transmission mechanisms of IX and VP policies in the special case of unexpected and permanent policy changes and flexible wages.[3] Under flexible exchange

[2] See Calmfors (1998) for an early argument. Correia et al. (2013) also study the role of VAT changes when monetary policy is constrained by the ZLB.

[3] The exact conditions that characterize this special case also include that foreign-currency denominated bonds represent the only internationally traded asset and that exporters let prices vary one for one with exchange rates (PCP).

rates, IX and VP policies are equivalent and have no allocative effects, as they both are offset by a permanent real exchange rate appreciation of an amount equal to the size of the policy. Nonetheless, the two policies are only beguilingly equivalent, as they achieve neutrality through different adjustments. In the case of IX, an immediate jump in the nominal exchange rate offsets the effect of the policy on import and export prices.[4] In the case of VP, the nominal exchange rate does not need to move at all. A jump in the nominal wage—proportional to the VAT hike—offsets the reduction in marginal costs caused by the payroll subsidy, thus inducing firms to keep labor demand unchanged. The nominal wage hike also makes households willing to keep their labor supply unchanged by offsetting the reduction in real wages caused by higher consumer prices. Notably, as VAT changes apply to both imported and domestic goods, the relative price of traded goods is unaffected, and consumer prices drive the appreciation of the real exchange rate. These considerations also underscore the different transmission channels of IX and VP policies, with the former affecting domestic firms' competitiveness in international markets, and the latter equilibrium in the domestic labor market.

The different general equilibrium adjustments that deliver neutrality of IX and VP provide the intuition for our first theoretical contribution to the fiscal devaluation literature: under fixed exchange rates, IX policies implement the same allocation as an exchange rate devaluation, but VP policies remain neutral. Given that IX policies require a nominal appreciation for neutrality, absent an exchange rate response, IX elicits economic effects identical to a currency depreciation. Instead, because the neutrality of VP does not require any adjustment in the nominal exchange rate, the fixed exchange rate regime does not pose any constraint to achieving the same neutrality outcome as under flexible exchange rates. This result is in contrast to FGI and reflects a key difference between our frameworks. In particular, while we assume that pretax prices are sticky and VAT changes are fully passed through to consumer prices, FGI assume that prices are sticky *inclusive* of VATs and firms reduce margins in response to VAT increases.

We next provide a broader characterization of the macroeconomic effects of the two policies once we depart from the restrictive conditions of the special case described earlier. First, we abandon the assumption that agents believe that policy changes will remain in place forever. We use a Markov-switching framework to capture the possibility that policy actions may be reversed because of political shifts or that they may induce retaliation by other countries. Second, we consider the role of wage rigidity for the transmission of these policies. The appeal of competitiveness-enhancing payroll tax cuts financed with VAT hikes appears greater when nominal rigidities prevent a strong offsetting wage response.[5]

We find that, when IX is expected to be reversed or to trigger retaliation, it tends to boost output and inflation *even under flexible exchange rates*. In this case, the exchange rate must eventually return to its pre-shock level, and, as a consequence, the

[4] This finding can be interpreted as an application of Lerner (1936) to dynamic economies. See also Costinot and Werning (2017).

[5] For an early argument in favor of variations in payroll taxes in the presence of wage rigidities, see Calmfors (1998). For a recent discussion on the effects of wage rigidity in a small open economy belonging to a currency union, see also Galí and Monacelli (2016).

immediate appreciation of the currency falls short of completely offsetting the expenditure-switching effects of the policy on imports and exports. We find that the resulting boost to net exports and output is robust to a wide range of environments, including departures from flexible wages and different monetary policy regimes.

The macroeconomic effects of VP are much more sensitive to the details of the environment. We first show that a VP policy that is not perceived as permanent, perhaps because it may be reversed by future governments, has contractionary effects due to an intertemporal substitution channel. As the expected decline in future VAT rates raises the price of current consumption relative to future consumption, households increase savings and aggregate demand declines. Thus, a temporary VP exerts a strong contractionary impetus unless monetary policy cuts interest rates sufficiently and is even more likely to reduce output under fixed exchange rates or in a currency union. That said, we then show that VP policies can provide macroeconomic stimulus if wages are sufficiently sticky and the policy shift is expected to be permanent or nearly so, as the reduction in firms' marginal costs induced by payroll subsidies is not fully offset by higher wages.

In sum, our novel theoretical predictions underscore the importance of assumptions about tax pass-through and expectations about the evolution of policies. Direct empirical evidence on these features is limited. Several studies find large and immediate pass-through of VAT increases to consumer prices.[6] However, existing evidence does not study pass-through during fiscal devaluations, and it is possible that firms' pricing response to VAT changes is different when payroll subsidies are also introduced.[7] Similarly, it is difficult to construct direct measures of agents' expectations about policy reversal. For these reasons, we employ an indirect inference approach to provide some evidence about these two key features of our analysis.

We consider the 2007 fiscal policy reform in Germany as a laboratory to study the extent to which VP and IX policies can, quantitatively, provide as much stimulus as a currency devaluation. In January 2007, the German government simultaneously increased VAT rates and reduced payroll taxes by similar magnitudes. We document that, in the data, this VP policy was associated with a large pass-through of the VAT increase to consumer prices and a contraction in domestic demand and output, notwithstanding a small boost to net exports. We then use a medium-scale version of our model—extended to allow for heterogeneity in the price response to VAT changes—to study whether this fiscal reform can account for the economic underperformance of Germany in 2007. We estimate the values of the parameters controlling the share of firms that fully pass through VAT changes and the perceived persistence of the policy change so that they minimize the distance between the German data on output and inflation and the corresponding model simulated series. We find that the estimated model response to the VP policy can account well for the dynamics of key German macroeconomic variables over 2007.

Our estimates suggest that a sizeable fraction of firms passed through the VAT increase quickly, and that agents attached a significant probability to an eventual

[6] See, for instance, Carbonnier (2007), Cashin and Unayama (2016), and Karadi and Reiff (2019). The range of estimates for the pass-through of a VAT increase in these studies is always above 60 percent.

[7] We thank Emmanuel Farhi for this comment.

policy reversal.[8] As a result, intertemporal substitution effects dominate and contribute to a drag on output, consumption, and investment. The limiting assumption of permanent policy changes and gradual pass-through of VAT increases, typically adopted in the fiscal devaluation literature, appears strongly rejected by the data.

We then compare the effects of the German VP to those that our model would imply if Germany could implement an IX policy or a currency devaluation. While Germany's euro-area membership would preclude it from pursuing the latter policies, it is interesting to consider whether they would be more potent in delivering stimulus than VP if feasible to deploy. In line with our theoretical predictions, we find that IX would have delivered an output boost through its effects on external competitiveness. That said, an IX policy that is expected to be reversed has only a muted effect on aggregate demand and hence provides a much smaller boost to output than a currency devaluation.

The paper is organized as follows. Section I describes the model. Section II develops some intuition about the effects of IX and VP starting from conditions for equivalence and neutrality. Section III discusses the transmission mechanisms of IX and VP policies once we depart from the conditions for equivalence and neutrality, with a focus on policy reversals and on sticky wages. Section IV presents our quantitative analysis about the implementation of a VP policy in Germany in 2007. Section V concludes.

I. Model

The economy consists of a home (H) country and a foreign (F) country that are isomorphic in structure. Foreign variables are denoted with an asterisk. Agents in each economy include households, retailers, producers of intermediate goods, and the government. For ease of exposition, the next sections describe the optimization problems solved by each type of agent under the assumptions of producer currency pricing (PCP), fully flexible wages, and a simple financial market structure in which only a foreign currency bond is traded internationally. The online Appendix presents a more general model that allows for alternative assumptions about price and wage setting and financial market structure, as well as for differences in country size; all of the theoretical results are derived within the context of this general framework.

A. *Households*

Households in the home country derive utility from a final good consumption (C_t) and disutility from labor (N_t). They maximize expected lifetime utility

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t) \tag{1}$$

[8] While obtained purely from aggregate data, our estimate of high tax pass-through is in line with the heterogeneous pricing response across firms documented in Bundesbank (2007). The positive probability of policy reversal is consistent with reasonable assumptions about the likelihood of political turnover and its implications for the evolution of fiscal policy, as discussed in D'Acunto, Hoang, and Weber (2016).

subject to the budget constraint

$$(2) \qquad P_t C_t + B_{Ht} + \varepsilon_t \Big[B_{Ft} + \frac{\chi}{2} \big(B_{Ft} - \bar{B}_F \big)^2 \Big]$$
$$= R_{t-1} B_{Ht-1} + \varepsilon_t R^*_{t-1} B_{Ft-1} + W_t N_t + \tilde{\Pi}_t + T_t,$$

where P_t is the consumer price index, B_{Ht} are noncontingent nominal bond holdings denominated in domestic currency, B_{Ft} are noncontingent nominal bond holdings denominated in foreign currency, R_t is the domestic nominal interest rate, R^*_{t-1} 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 the home currency), W_t is the wage rate, $\tilde{\Pi}_t$ is the aggregate profit of the home firms assumed to be owned by the home consumers, and T_t is a lump-sum transfer from the government. The parameter $\chi \geq 0$ allows for the possibility that home households face quadratic costs of adjusting their holdings of foreign bonds.[9, 10]

We assume that the period utility function takes the form

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

Optimality requires

$$(4) \qquad N_t^{\eta} C_t^{\sigma} = \frac{W_t}{P_t},$$

$$(5) \qquad 1 = E_t \Big[\Lambda_{t,t+1} \frac{P_t}{P_{t+1}} R_t \Big],$$

$$(6) \qquad 1 = E_t \Big[\Lambda_{t,t+1} \frac{P_t}{P_{t+1}} \frac{\varepsilon_{t+1}}{\varepsilon_t} R^*_t \Big],$$

where $\Lambda_{t,s} = \beta^{s-t} \big(C_t / C_s \big)^{\sigma}$ is the real stochastic discount factor of the home household. The corresponding optimality condition for foreign household holdings of the foreign bond is

$$(7) \qquad 1 = E_t \Big[\Lambda^*_{t,t+1} \frac{P^*_t}{P^*_{t+1}} R^*_t \Big].$$

Combining the optimality conditions for bond holdings (6) and (7), one obtains the risk-sharing condition

$$(8) \qquad E_t \Big[\Big(\Lambda_{t,t+1} \frac{Q_{t+1}}{Q_t} - \Lambda^*_{t+1} \Big) \frac{P^*_t}{P^*_{t+1}} \Big] = 0,$$

[9] All of our theoretical results go through irrespective of the value of χ provided that $\chi \geq 0$. For simplicity, the first-order conditions reported in the text assume $\chi = 0$. In our simulations, we introduce very small costs of adjustment to ensure stability of a first-order approximation. See Schmitt-Grohé and Uribe (2003).

[10] In our baseline calibration we focus on the case, often considered in the literature, in which foreign households cannot invest in the domestic bond so that only the foreign bond is traded internationally. That is, the budget constraint for foreign households is given by $P^*_t C^*_t + B^*_{Ft} + (1/\varepsilon_t) \big[B^*_{Ht} + (\chi^*/2) (B^*_{Ht} - \bar{B}_H)^2 \big] = R^*_{t-1} B^*_{Ft-1} + (1/\varepsilon_t) R_{t-1} B^*_{Ht-1} + W^*_t N^*_t + \tilde{\Pi}^*_t + T^*_t$. In our baseline analysis, we set $\chi^* = \infty$ so that only foreign currency bonds are traded internationally.

where Q_t is the real exchange rate expressed as the price of the foreign consumption bundle in terms of the domestic consumption bundle, that is

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

B. *Retailers*

Competitive home retailers combine home and foreign intermediate goods to produce the final consumption 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 intermediate goods and $\omega_H \in [0.5, 1]$ governs home bias. The home good (Y_{Ht}) and the foreign good (Y_{Ft}) consist of CES aggregators over home and foreign varieties

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

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

where $\gamma \geq 0$ determines the elasticity of substitution across varieties.

Profits for the home retailers are

$$\Pi_t^R = (1-\tau_t^v)(P_t C_t - P_{Ht} Y_{Ht} - P_{Ft} Y_{Ft}), \tag{13}$$

where P_{Ht} and P_{Ft} are the price indexes of the home and foreign goods and τ_t^v is the VAT rate. Prices are inclusive of VATs and, in the case of imported goods, are also inclusive of home tariffs (τ_t^m).

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

$$Y_{Ht} = \omega\left(\frac{P_{Ht}}{P_t}\right)^{-\theta} C_t, \tag{14}$$

$$Y_{Ft} = (1-\omega)\left(\frac{P_{Ft}}{P_t}\right)^{-\theta} C_t, \tag{15}$$

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

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

The zero profit conditions for home retailers imply that price indexes satisfy

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

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

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

C. *Producers*

Each country features a continuum $i \in [0,1]$ of monopolistically competitive firms that produce different varieties of intermediate goods using the technology

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

where $Y_{Ht}(i)$ and $Y_{Ht}^*(i)$ are firm i's sales in the domestic and foreign market, respectively; A_t is the aggregate level of technology; and $\alpha \in (0,1)$ controls the curvature of the production function.

In our benchmark specification, producers set prices in the domestic currency while letting prices in the foreign market adjust to ensure that unit revenues are equalized across markets (PCP). Firm i's profits are

$$\Pi_t^P(i) = P_{Pt}(i)\left[Y_{Ht}(i) + Y_{Ht}^*(i)\right] - (1-\varsigma_t^p) W_t N_t(i), \tag{22}$$

where $P_{Pt}(i)$ denotes the unit revenue from domestic sales of the home variety and ς_t^p is a payroll subsidy to employers.

The presence of VATs introduces a wedge between unit revenues $P_{Pt}(i)$ and the price paid by domestic retailers for $P_{Ht}(i)$:

$$P_{Pt}(i) = (1-\tau_t^v) P_{Ht}(i). \tag{23}$$

Similarly, import tariffs (τ_t^m) and export subsidies (ς_t^x) create a wedge between the foreign currency price paid by foreign retailers, $P_{Ht}^*(i)$, and firm i's foreign currency unit revenue from exports, $P_{Pt}(i)/\varepsilon_t$:

$$P_{Ht}^*(i) = \frac{(1+\tau_t^{m*})}{(1+\varsigma_t^x)(1-\tau_t^{v*})} \frac{P_{Pt}(i)}{\varepsilon_t}. \tag{24}$$

Producers set prices in staggered contracts by following a Calvo-style timing assumption and with full pass-through of VATs. That is, a domestic firm that adjusts its price at time t sets the unit revenues $P_{Pt}(i)$ and, absent any price adjustment until

time $s > t$, changes in VATs are fully reflected in retailers' costs of purchasing the home variety

$$P_{Hs}(i) = \frac{P_{Pt}(i)}{(1-\tau_s^v)}. \tag{25}$$

Each firm that reoptimizes at time t will then choose $\bar{P}_{Pt,}$ to solve

$$\max E_t \sum_{s \geq t} \zeta_P^{s-t} \Lambda_{t,s} \left\{ \frac{\bar{P}_{Pt}(i)\left[Y_{Hs}(i) + Y_{Hs}^*(i)\right] - (1-\varsigma_s^p) W_s N_s(i)}{P_s} \right\}, \tag{26}$$

where ζ_P is the probability that the firm will not be able to adjust its price in any given period, labor demand satisfies (21) while domestic and foreign sales are determined by retailers' demand schedules in both the home and foreign market (i.e., equation (16) and its foreign analogue, respectively). The reset price $\bar{P}_{Pt}(i)$ is a fixed markup over a weighted average of future marginal costs

$$\bar{P}_{Pt}(i) = (1-\varsigma_t^p) E_t \sum_{s \geq t} \tilde{\Lambda}_{t,s}(i) \frac{(1-\varsigma_s^p)}{(1-\varsigma_t^p)} \frac{\gamma}{\gamma - 1} \frac{W_s}{\alpha A_s N_s^{\alpha-1}(i)}, \tag{27}$$

where the weights

$$\tilde{\Lambda}_{t,s}(i) = \frac{\zeta_P^{s-t} \Lambda_{t,s} \frac{P_t}{P_s}\left[Y_{Hs}(i) + Y_{Hs}^*(i)\right]}{E_t \sum_{u \geq t} \zeta_P^{u-t} \Lambda_{t,u} \frac{P_t}{P_u}\left[Y_{Hu}(i) + Y_{Hu}^*(i)\right]} \tag{28}$$

take into account the probability that the contract price will remain in effect, ζ_P^{s-t}; households' relative value of money over time, $\Lambda_{t,s}(P_t/P_s)$; and firms' future sales volumes $\left[Y_{Hs}(i) + Y_{Hs}^*(i)\right]$.

We let the domestic producer price index P_{Pt} be defined in a way that mimics the consumer price index in (19):

$$P_{Pt} = \left[\int P_{Pt}(i)^{1-\gamma} di\right]^{\frac{1}{1-\gamma}}, \tag{29}$$

and our Calvo-style pricing assumption then implies that domestic producer price inflation is given by

$$\pi_{P,t} = \left[\zeta_P + (1-\zeta_P)\left(\frac{\bar{P}_{P,t}}{P_{P,t-1}}\right)^{1-\gamma}\right]^{\frac{1}{1-\gamma}}. \tag{30}$$

Expression (30) indicates that domestic producer price inflation depends on future marginal costs through the optimal reset price $\bar{P}_{P,t}$, which is identical across all firms that reset at time t. Combining equations (27) and (30), one obtains the familiar New Keynesian Phillips curve linking domestic producer price inflation to current and future marginal costs.

Similarly, foreign firm j sells its good in the foreign country at a price of $P^*_{Ft}(j)$ and in the home country according to the PCP condition:

$$P_{Ft}(j) = \frac{(1+\tau^m_t)}{(1+\varsigma^{x*}_t)(1-\tau^v_t)}\varepsilon_t P^*_{Pt}(j). \tag{31}$$

Foreign firms that are allowed to reset their price choose their contract price $\bar{P}^*_{Pt}(j)$ so that

$$\bar{P}^*_{Pt}(i) = (1-\varsigma^{p*}_t)E_t\sum_{s\geq t}\tilde{\Lambda}^*_{t,s}(i)\frac{(1-\varsigma^{p*}_s)}{(1-\varsigma^{p*}_t)}\frac{\gamma}{\gamma-1}\frac{W^*_s}{\alpha A^*_s N^{*\alpha-1}_s(i)}. \tag{32}$$

D. *Government Policy*

Fiscal policy in the home country and in the foreign country is characterized by the vector of fiscal instruments:

$$s_t = (\tau^m_t, \varsigma^x_t, \tau^v_t, \varsigma^p_t, \tau^{m*}_t, \varsigma^{x*}_t, \tau^{v*}_t, \varsigma^{p*}_t). \tag{33}$$

We assume that policy actions $s_t \in S$ follow a finite-state Markov chain. We consider IX and VP policies in isolation. Specifically, when considering IX, the policy regime is in one of three different states: $s_t \in S^{IX} = \{s^{NT}, s^{IX}, s^{IX,IX}\}$. In the first state (s^{NT}), no country levies any import tariffs or provides any export subsidy ("No Tax" state). In the second state (s^{IX}), the home country unilaterally adopts an IX policy that raises import tariffs and export subsidies by the same amount δ (i.e., $\tau^m_t = \varsigma^x_t = \delta$). In the third state $(s^{IX,IX})$, the foreign country retaliates in a symmetric way by raising its own tariffs and subsidies by the same amount as the home country, i.e., $\tau^m_t = \varsigma^x_t = \tau^{m*}_t = \varsigma^{x*}_t = \delta$. Similarly, when considering VP policies, we assume that $s_t \in S^{VP} = \{s^{NT}, s^{VP}, s^{VP,VP}\}$.

The transition probability matrix Ω can be expressed as

$$\Omega^z = \begin{bmatrix} 1-a & a & 0 \\ (1-\pi)(1-\rho) & \rho & \pi(1-\rho) \\ (1-\varphi) & 0 & \varphi \end{bmatrix}, \tag{34}$$

where $z \in \{IX, VP\}$ and element $\Omega_{i,j}$ indicates the probability of moving from state i to state j. For instance, the first row of matrix Ω^{IX} implies that the transition from the no-tax state s^{NT} to the s^{IX} state—where the home country implements the IX policy unilaterally—is anticipated with probability a. The second row indicates that, given an implementation of IX, the economy remains in the state s^{IX} with probability ρ, returns to the no-tax state with probability $(1-\pi)(1-\rho)$, and transitions to the retaliation state $s^{IX,IX}$ with probability $\pi(1-\rho)$. Once the foreign country retaliates, the economy returns to a no-tax state with probability $1-\varphi$, while, with probability φ, it remains in the trade war regime. In this specification, the foreign

country does not abandon its retaliatory policies unilaterally, so a trade war can end only through a coordinated policy reversal by both countries.[11]

This general specification for the policy regime is helpful for considering a wide range of policy configurations and dynamics as special cases. These include unilateral changes in policies that are either permanent or expected to eventually be reversed, and also foreign retaliation. Moreover, the Markov structure can be used to study how expectations of future changes in policies affect current macroeconomic outcomes.

The home government balances its budget in every period through lump-sum transfers T_t:

$$T_t = \left(\frac{\tau_t^m + \tau_t^v}{1 + \tau_t^m}\right) P_{Ft} Y_{Ft} + \tau_t^v P_{Ht} Y_{Ht} - \frac{\varsigma_t^x}{\left(1 + \varsigma_t^x\right)} P_{Pt} Y_{Ht}^* - \varsigma_t^p W_t N_t. \tag{35}$$

Monetary policy follows a Taylor-style interest rate rule:

$$R_t = \frac{1}{\beta}\left(\pi_{Pt}\right)^{\varphi_\pi}\left(\tilde{y}_t\right)^{\varphi_y}\left(\tilde{\varepsilon}_t\right)^{\varphi_\varepsilon}, \tag{36}$$

where φ_π is the weight on producer price inflation $\left(\pi_{Pt}\right)$, φ_y is the weight on the output gap $\left(\tilde{y}_t\right)$, and φ_ε determines how policy rates respond to deviations of the nominal exchange rate from an exchange rate target (i.e., $\tilde{\varepsilon}_t = \varepsilon_t/\bar{\varepsilon}$).[12] When $\varphi_\varepsilon = 0$, the home interest rate responds exclusively to fluctuations in the output gap and domestic inflation. This specification implies that the central bank looks through changes in inflation due to the direct effects of tariffs and VATs. When $\varphi_\varepsilon = M$, with M large, the interest rate is set so that the country pegs its exchange rate to a predetermined target $\left(\bar{\varepsilon}\right)$.

E. *Market Clearing and Equilibrium*

Labor market clearing equates households' labor supply to aggregate firms' demand

$$N_t = \int N_t(i)\,di. \tag{37}$$

Bond market clearing requires

$$B_{Ft} + B_{Ft}^* = 0, \tag{38}$$

$$B_{Ht} + B_{Ht}^* = 0. \tag{39}$$

[11] In our calibration the exact value of φ does not have material effects on outcomes (see the discussion in the online Appendix). Thus, in our experiments, we set φ equal to ρ.

[12] Since Galí and Monacelli (2005), the targeting of domestic producer price inflation in open-economy New Keynesian models has become standard practice. See also Galí and Monacelli (2016). The output gap in the Taylor rule is constructed as output relative to the level of output that would prevail in the absence of price rigidity. For a discussion of interest rate rules that maintain a fixed exchange rate, see Benigno, Benigno, and Ghironi (2007).

Combining home and foreign households' budget constraints and using the bond market clearing conditions, we get a balance of payments equilibrium equation,

$$\varepsilon_t B_{Ft} - B^*_{Ht} = \varepsilon_t B_{Ft-1} R^*_{t-1} - B^*_{Ht-1} R_{t-1} + NX_t, \tag{40}$$

which requires that home households increase their holdings of foreign bonds to meet the total amount of new borrowing demand from abroad, given by home net exports:

$$NX_t = \frac{P_{Pt}}{\left(1 + \varsigma^x_t\right)} Y^*_{Ht} - \varepsilon_t \frac{P^*_{Pt}}{\left(1 + \varsigma^{x*}_t\right)} Y_{Ft}. \tag{41}$$

This completes the description of the model. See the online Appendix for a formal definition of the equilibrium.

II. Trade and Fiscal Policies: A Theoretical Analysis

In this section, we discuss the key differences in transmission of IX and VP policies. To this end, we first summarize conditions under which both IX and VP are equivalent and have no allocative effects under flexible exchange rates, and we highlight the key role of the real exchange rate as an adjustment mechanism. We show that, under such extreme conditions, these two policies look only beguilingly similar, as the forces driving the adjustment in the real exchange rate are fundamentally different.

We then present the main result of this section: under fixed exchange rates, IX policies implement a currency devaluation and provide macroeconomic stimulus, whereas VP policies remain neutral. As these findings appear in contrast with conventional wisdom (such as, for instance, FGI), we conclude this section with a discussion of the key assumption about tax pass-through.

A. *Neutrality under Flexible Exchange Rates*

PROPOSITION 1: *In an economy with flexible exchange rates* ($\varphi_\varepsilon = 0$), *both a unilateral IX policy of size* δ *and a unilateral VP policy of size* $\delta/(1+\delta)$ *cause a* δ*-percent appreciation of the real exchange rate and have no allocative effect if*

(*i*) *The policy is permanent and unanticipated, and there is no probability of retaliation* ($a = \pi = 0$, *and* $\rho = 1$);

(*ii*) *Foreign holdings of home-currency-denominated bonds are always zero* ($\chi^* = \infty$);

(*iii*) *Export prices are set in the producer's currency* (*PCP*), *or prices are flexible*.

The result of IX neutrality contained in Proposition 1 extends Lerner's Symmetry Theorem (Lerner 1936) to our dynamic monetary framework.[13] Similarly, neutrality

[13] For other work on Lerner's symmetry result, see, for instance, McKinnon (1966) and, more recently, Costinot and Werning (2017). Eichengreen (1981) provides an intuitive discussion of the conditions needed to achieve

of VP has been discussed in the literature within static models of international trade.[14] The greater relevance of this result for our purposes is that it provides a theoretical benchmark to illustrate the different general equilibrium adjustments that deliver equivalence and neutrality in response to the two policies. This discussion will provide most of the intuition for how the relaxation of conditions (i)–(iii) of Proposition 1 affects transmission of IX and VP. We include the formal proof of Proposition 1 in the online Appendix.[15]

As stated in the proposition, in response to both unilateral IX and VP, the real exchange rate appreciates permanently by an amount equal to the size of the policy. That is, the relative price of the foreign consumption bundle in terms of the domestic consumption bundle

$$Q_t = \varepsilon_t \frac{P_t^*}{P_t} = \varepsilon_t (1 - \tau_t^v) \frac{P_{p_t}^*}{P_{p_t}} \tag{42}$$

declines permanently by δ, where δ is the size of the policy.[16] In the case of IX, this real exchange rate adjustment happens through a jump in the nominal exchange rate (ε_t). In the case of VP, however, the adjustment is mechanically induced by the VAT increase which raises home consumer prices. Hence, VP does not require any change in the value of the currency.

To illustrate why this is the case, it is useful to collect the key equilibrium conditions into two blocks. The first block collects the conditions that regulate trade among countries and its intermediation through foreign bonds:

$$\frac{Y_{Ft}}{Y_{Ht}} = \left[(1 + \tau_t^m) \varepsilon_t \frac{P_{Pt}^*}{P_{Pt}} \right]^{-\theta}, \tag{43}$$

$$\frac{Y_{Ht}^*}{Y_{Ft}^*} = \left[\frac{1}{(1 + \varsigma_t^x) \varepsilon_t} \frac{P_{Pt}}{P_{Pt}^*} \right]^{-\theta}, \tag{44}$$

$$B_{Ft} - \frac{B_{Ht}^*}{\varepsilon_t} = B_{Ft-1} R_{t-1}^* - \frac{B_{Ht-1}^*}{\varepsilon_t} R_{t-1} + \frac{P_{Pt}}{(1 + \varsigma_t^x) \varepsilon_t} \left[Y_{Ht}^* - (1 + \varsigma_t^x) \varepsilon_t \frac{P_{Pt}^*}{P_{Pt}} Y_{Ft} \right], \tag{45}$$

$$\varepsilon_t = R_t^* E_t \left[\Lambda_{t,t+1} \varepsilon_{t+1} \frac{P_{Pt}}{P_{Pt+1}} \frac{1 - \tau_{t+1}^v}{1 - \tau_t^v} \times \left\{ \frac{\omega + (1 - \omega) \left[(1 + \tau_t^m) \varepsilon_t \frac{P_{Pt}^*}{P_{Pt}} \right]^{1-\theta}}{\omega + (1 - \omega) \left[(1 + \tau_{t+1}^m) \varepsilon_{t+1} \frac{P_{Pt+1}^*}{P_{Pt+1}} \right]^{1-\theta}} \right\}^{\frac{1}{1-\theta}} \right]. \tag{46}$$

neutrality in a framework similar to ours. Lerner's Symmetry Theorem is also a relevant result for the neutrality of border tax adjustments, as in Auerbach et al. (2017), Erceg, Prestipino, and Raffo (2018b), Lindé and Pescatori (2019), and Barbiero et al. (2018).

[14] See, for instance, Auerbach et al. (2017).

[15] While we do not prove that these conditions are necessary, we illustrate in Section III and in the online Appendix that they are *tight* in the sense that relaxing any one of them breaks the neutrality of IX.

[16] All equations reported in this section abstract from foreign instruments for ease of exposition, given that under condition (i) in Proposition 1 and Proposition 2 foreign governments do not retaliate to the policies considered.

Equations (43) and (44) determine the relative demand for domestic and foreign varieties in the home and foreign country.[17] Equations (45) and (46) determine equilibrium in the foreign-currency-denominated bond market. Equation (45) equates home demand for new foreign-currency bonds with foreign supply as determined by the level of foreign trade deficits. Demand for foreign-currency bonds in the home country is determined by equation (46).

Equations (43) and (44) show that, for a given level of the exchange rate, import tariffs and export subsidies shift demand away from foreign goods and toward domestically produced goods, both in the home country and in the foreign country. However, the relative prices of imported to domestic goods in the righthand sides of equations (43) and (44) remain unchanged if a δ-percent increase in both import tariffs and export subsidies causes an exchange rate appreciation of the same exact size. In other words, under PCP, the exchange rate appreciation lowers the cost of imports in the home country just enough to offset the increase in tariffs and lowers the revenues from sales of domestic varieties in the foreign country by as much as the higher export subsidy. Equation (43) also shows why the assumption of PCP is important in delivering the result as it ensures that foreign exporters' prices, $\varepsilon_t P^*_{Pt}$, immediately reflect exchange rate fluctuations. If foreign exporters were unable to do so—such as under local currency pricing—this neutrality result would immediately break.[18] Moreover, as shown in equation (45), the currency appreciation offsets the effect of export subsidies on net exports and leaves the balance of payments unaffected, as, under condition (ii) of Proposition 1, all trade is intermediated in foreign-currency-denominated bonds (i.e., $B^*_{Hs} = 0$ for all s).[19] Finally, equation (46) shows that as long as the IX policy change is permanent, demand for foreign currency bonds is unaffected. Section 3 discusses in detail how departures from condition 1 of Proposition 1 affect the transmission of IX by implying that the exchange rate offset to the policy change is only partial.

Regarding VP, equations (43)–(45) make clear that this policy has no direct effect on relative demand for home and foreign varieties and, hence, on net exports. This observation is a consequence of the fact that VAT changes affect equally the price of imported and domestically-produced goods.[20] In addition, as long as it is permanent, VP does not affect home savings demand and, thus, also leaves (46) unaffected. Consequently, under VP, no general equilibrium adjustment of the nominal exchange rate is required to insulate international relative prices from the effects of the policy.

The second block of equations collects the conditions determining equilibrium in the domestic labor market and aggregate demand:

$$(47) \qquad W_t(1-\tau_t^v) = \left\{\omega + (1-\omega)\left[(1+\tau_t^m)\varepsilon_t \frac{P^*_{Pt}}{P_{Pt}}\right]^{1-\theta}\right\}^{\frac{1}{1-\theta}} P_{Pt} C_t^\sigma N_t^\eta,$$

[17] Equation (43) can be derived from the demand schedules in (14) and (15), and the PCP conditions (25) and (31). Analogous derivations for the foreign economy yield (44).

[18] We discuss alternative pricing assumptions in more detail in the online Appendix.

[19] The online Appendix discusses the case in which foreign households can hold home currency bonds.

[20] See Feldstein and Krugman (1990) for a similar argument.

$$\bar{P}_{Pt}(i) = (1 - \varsigma_t^p) E_t \sum_{s \geq t} \tilde{\Lambda}_{t,s}(i) \frac{(1 - \varsigma_s^p)}{(1 - \varsigma_t^p)} \frac{\gamma}{\gamma - 1} \frac{W_s}{\alpha A_s N_s^{\alpha-1}(i)}, \tag{48}$$

$$\beta E_t \left[\frac{C_t^{\sigma}}{C_{t+1}^{\sigma}} \frac{R_t}{\pi_{pt+1}} \frac{1 - \tau_{t+1}^v}{1 - \tau_t^v} \left\{ \frac{\omega + (1-\omega)\left[(1+\tau_t^m)\varepsilon_t \frac{P_{Pt}^*}{P_{Pt}}\right]^{1-\theta}}{\omega + (1-\omega)\left[(1+\tau_{t+1}^m)\varepsilon_{t+1} \frac{P_{Pt+1}^*}{P_{Pt+1}}\right]^{1-\theta}} \right\}^{\frac{1}{1-\theta}} \right] = 1. \tag{49}$$

IX enters (47) and (49) only through its effect on import prices, which, as explained earlier, is perfectly offset by the currency appreciation.

The transmission of VP, instead, works through its direct effects on the equilibrium in the labor market. Equations (47) and (48) show that the increase in the payroll subsidy and the VAT hike have offsetting effects on labor demand and labor supply. Under our assumption of full pass-through of taxes, at fixed producer prices, a VAT hike induces consumer prices (P_t) to jump by δ percent (see equation (23)). In order for the households' labor supply to remain unchanged, equation (47) requires an adjustment in the nominal wage of the same exact percentage of the VAT hike. In addition, as evident from the optimal pricing decision of producers (48), the commensurate increase in payroll subsidies (ς_t^p) ensures that firms are willing to pay this higher wage, so that labor demand is also unaffected. Equation (48) also implies that a VP policy that is expected to be eventually reversed would have direct effects on aggregate supply, breaking the neutrality result. The importance of assumption 1 in Proposition 1 for the neutrality of VP can also be seen by inspection of the intertemporal optimality conditions for households consumption. In particular, the intertemporal substitution effects induced by expectations about the future declines in the VAT, as implied by equation (49), turn out to have large quantitative effects on the economic response to VP. We will discuss this channel in detail in Section IIIA and assess its quantitative relevance in our empirical experiment of Section IVD.

B. *Fiscal Devaluations Revisited*

We now turn to study the effects of IX and VP policies under the assumption that exchange rates are fixed by the monetary policy of the home economy.

PROPOSITION 2: *In a fixed exchange rate regime* $(\varphi_{\varepsilon} = \infty)$, *under assumptions* (i)–(iii) *of Proposition 1, an IX policy of size* δ *has the same allocative effects as a once-and-for-all unexpected currency devaluation of size* δ. *A VP policy of the same size* $\delta/(1+\delta)$ *has no effect on the allocation but causes the real exchange rate to appreciate by* δ.[21]

[21] Condition (iii) of Proposition 1 also includes the possibility that prices are flexible. In this case both policies are equivalent and neutral. We thank an anonymous referee for pointing this out.

After our earlier discussion about how neutrality is achieved by IX and VP, this result should come as no surprise. Given that when the currency exchange rate is free to move, the effects of an IX policy are perfectly offset by a nominal appreciation, it follows that, absent an exchange rate response, IX elicits economic effects identical to a currency depreciation. In contrast, as VP neutrality does not require any adjustment in the currency exchange rate, the fixed exchange rate regime does not pose any constraint to achieving the same outcome as under flexible exchange rates. VP remains neutral under fixed exchange rates.

The neutrality of VP under fixed exchange rates is in contrast with recent results in the fiscal devaluation literature, such as FGI. The key difference between the two frameworks is the assumption about how VAT changes are passed through to consumer prices in the presence of nominal rigidities. Our analysis assumes that pretax prices are sticky and taxes are fully passed through. Specifically, we assume that absent a price adjustment by the firm, producer prices P_{Pt} remain unchanged and consumer prices $P_{Ht} = P_{Pt}/(1 - \tau_t^v)$ jump in response to a VAT increase. In the fiscal devaluation literature, instead, prices are typically assumed to be sticky inclusive of taxes (and hence pretax prices are free to adjust). That is, firms control directly consumer prices $P_{H,t}$ and, absent price adjustment by the firm, VAT increases are absorbed through a reduction in firms' margins, i.e., producer prices decline $P_{pt} = P_{Ht}(1 - \tau_t^v)$. To understand how this assumption would affect transmission of VP through the margin determining relative demand for domestic and foreign varieties, we rewrite (43) and (44) using consumer prices rather than producer prices:

$$\frac{Y_{Ft}}{Y_{Ht}} = \left[\frac{(1 + \tau_t^m)\varepsilon_t}{(1 - \tau_t^v)} \frac{P_{Pt}^*}{P_{Ht}}\right]^{-\theta}, \tag{50}$$

$$\frac{Y_{Ht}^*}{Y_{Ft}^*} = \left[\frac{(1 - \tau_t^v)}{(1 + \varsigma_t^x)\varepsilon_t} \frac{P_{Ht}}{P_{Pt}^*}\right]^{-\theta}. \tag{51}$$

Notice that, by virtue of (23), equations (50) and (51) are equivalent to (43) and (44). Equations (50) and (51), however, make clear that if the adjustment in consumer prices, P_{Ht}, is sluggish in response to a VAT increase, then the VAT policy itself gives domestic firms a competitive boost and acts exactly as the IX policy. Under our assumption that firms' prices P_{Pt} are slow to adjust, in contrast, this competitiveness-enhancing effect of VATs disappears, as evident from (43) and (44).

III. Macroeconomic Effects of IX and VP Policies

In this section, we provide a broader characterization of the macroeconomic effects of IX and VP policies and their different transmission mechanisms. To this end, we focus on two departures from the limiting case considered in Section II that appear to be the most relevant both qualitatively and quantitatively.[22] Specifically, we first study the role of agents' beliefs about the persistence of tax changes and

[22] The Appendix contains a full treatment of deviations from the remaining conditions.

Table 1—Baseline Model Calibration

	Parameter	Value
Discount factor	β	0.99
Risk aversion	σ	1.00
Frisch elasticity of labor supply	η^{-1}	1.00
Labor share	α	0.64
Good variety elasticity	γ	11.0
Price stickiness	ζ_P	0.85
Trade elasticity	θ	1.25
Import share	$1-\omega_H$	0.15
Output gap weight in the Taylor rule	φ_y	0.125
Inflation weight in the Taylor rule	φ_π	1.50

the risk of retaliation by the foreign economy. We show that, when IX policies are expected to be reversed (or trigger symmetric retaliatory policies abroad), they exert sizable expansionary effects *even under flexible exchange rates*. In contrast, when VP policies are expected to be eventually reversed, intertemporal substitution effects tend to make them contractionary, *especially if monetary policy is constrained as in a currency union*. We then turn to the role of wage rigidity in affecting transmission of the two policies. While transmission of IX is affected only quantitatively by the presence of wage rigidities, VP policies have a better chance providing macroeconomic stimulus when wages adjust sluggishly as payroll subsidies boost aggregate supply.

In our discussion, we calibrate the model with fairly standard values used in the literature, which are reported in the top panel of Table 1.[23]

A. *IX and VP Policies: The Role of Reversal*

The neutrality of IX policies in our dynamic framework requires that the real exchange rate jumps to a new long-run value, reflecting the public's belief that trade actions will remain in place forever. However, historical experience suggests that trade policy actions are often reversed or spur retaliation. These reversals may occur because the trade policies are implemented as cyclical measures to boost the economy or as a negotiating tool in foreign policy.[24] Alternatively, they may result from an electoral shift toward a political party more supportive of free trade.[25] Moreover, although some trade policy legislation has been enacted with the expectation that it would remain in effect for a long time, the tariff wars that ensued during the 1930s

[23] See, for instance, Galí and Monacelli (2005).

[24] In this vein, Irwin (2017) discusses how President Nixon favored the imposition of a 10 percent across-the-board tariff in 1971 partly to enhance his prospects in the 1972 election, as well as to put pressure on foreign trading partners to revalue their exchange rates. As it turned out, the tariffs were lifted fairly quickly when the foreign policy objectives were viewed as largely achieved, as well as from pressure coming even from some members of the administration.

[25] For example, in the US experience, President Wilson, a free-trade Democrat, strongly supported the passage of the Underwood Tariff Act of 1913 which scaled back the high tariffs that had prevailed under previous Republican administrations (see Irwin 2017).

or, more recently, between the United States and China, serve to underscore the high likelihood of foreign retaliation under such circumstances.

Given these considerations, we next apply our benchmark model to study the effects of IX policies that have no long-run effect on the real exchange rate. Through the lens of our Markov structure, the effects on the exchange rate may prove temporary because the policy action is reversed or, alternatively, because the home country's implementation of IX policies prompts the foreign government to retaliate by adopting similar policies. As the implications of either type of policy turn out to be nearly identical, for expositional simplicity, we focus here on the case in which a unilateral IX policy is expected to be reversed $(1 - \rho > 0, \pi = 0)$.

In our benchmark framework, a unilateral IX policy of size δ that is expected to be reversed with probability $1 - \rho > 0$ exerts allocative effects by boosting real net exports, as the associated exchange rate appreciation only partially insulates international relative prices. To understand this result, it is helpful to recognize that for the allocation to remain unchanged, the exchange rate would have to appreciate by δ for as long as the policy remained in effect (by equations (43) and (44)). This exchange rate movement would completely offset the effects of IX on relative prices and leave the relative demand for imported and domestic varieties unaffected. However, the expectation that the IX policy will eventually be reversed implies that the home exchange rate depreciates in the future which in effect increases the return to holding foreign bonds (that is, $\varepsilon_{t+1} R_t$ rises), as seen from equation

$$\varepsilon_t = \beta E_t \left\{ \frac{C_t^\sigma}{C_{t+1}^\sigma} \frac{P_t}{P_{t+1}} \varepsilon_{t+1} \right\} R_t^*. \tag{52}$$

This increase in the return to holding foreign bonds dampens the initial appreciation of the home exchange rate—so that it is less than δ—and hence the IX policy leads to some expansion of net exports.[26,27]

The solid lines in Figure 1 show the expected paths of key variables after the home country adopts a unilateral IX policy in our benchmark model with sticky prices. The IX policy consists of a 10 percentage point increase in import tariffs and export subsidies that is expected to be reversed with probability $(1 - \rho) = 0.05$ by the following quarter. The policy causes a small appreciation of the exchange rate that does not fully insulate relative prices, and, as a consequence, imports fall and exports rise. Monetary policy reacts to the stronger external demand by raising interest rates, which reduces home consumption and contributes to the appreciation of the real exchange rate, thus dampening some of the stimulus to net exports. Because the stimulus to domestic output occurs through expenditure-switching channels, it has negative spillovers to the foreign economy so that both foreign output and inflation decline (not shown).

[26] The use of appropriately targeted capital controls, i.e., designed so that equation (52) holds without requiring an adjustment in the interest rate, would restore neutrality. We thank our discussant Emmanuel Farhi for this insight.

[27] Notably, this argument does not rely on nominal rigidities. In fact, transitory IX policies are non-neutral both under flexible prices and under sticky prices.

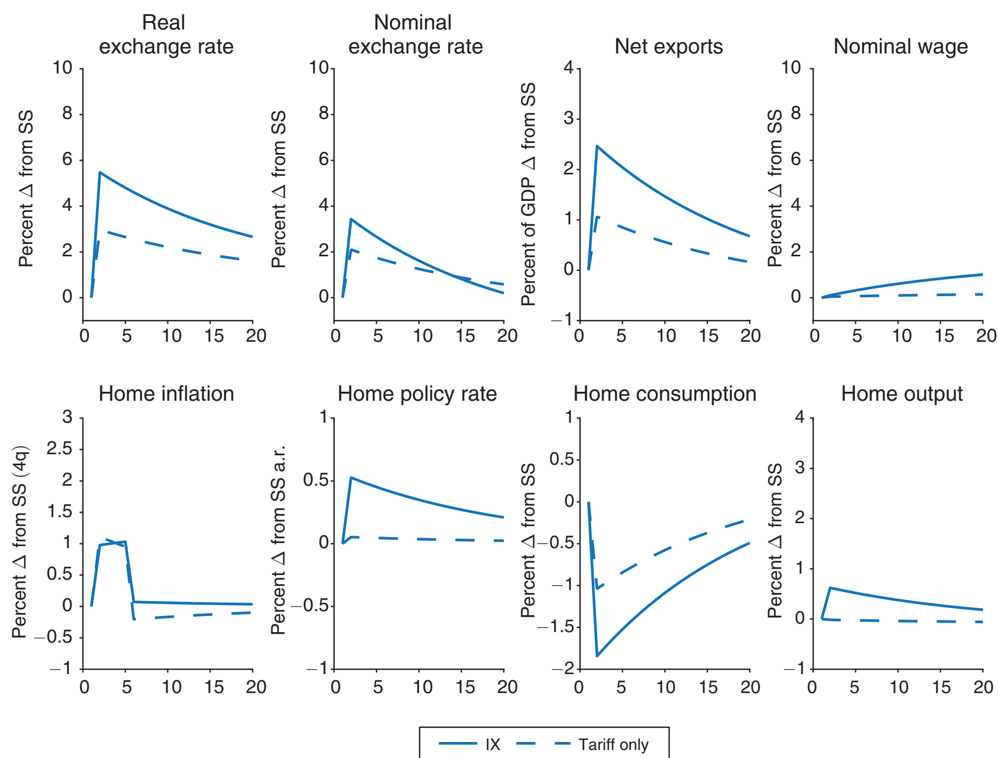

Figure 1. Macroeconomic Effects of IX with Expected Reversal

Notes: In both experiments we assume that prices are sticky, wages are flexible, and the exchange rate is flexible. The figure shows the expected path of each variable after the policy is implemented and given that it is expected to be permanently abandoned with probability 0.05 as long as it is in place.

IX policies operate not only through trade channels, but also through intertemporal channels. As seen in equation (49), an increase in import tariffs that is expected to be reversed raises the relative price of current consumption, as imported goods are expected to be cheaper in the future. These dynamic effects of tariffs not only differ markedly from the effects of export subsidies—which affect the real interest rate only through the strength of the monetary policy response—but also are quantitatively important in pushing down consumption.

Figure 1 also shows the effects of import tariffs alone (the dashed lines). An increase in import tariffs has essentially no effect on output under our baseline calibration ($\sigma = 1; \theta = 1.25$), so that all of the output stimulus from IX policies comes from the increase in export subsidies (i.e., the distance between the solid and dashed lines). The quasi-invariance of output to the tariff increase reflects that the expenditure-switching effect, which pushes up the desired share of consumption spent on home goods, is offset by the intertemporal-substitution effect, which pushes down overall consumption. Stepping beyond our specific calibration, we find that the output effects of higher import tariffs depend on the relative strength of these two effects. If the intertemporal elasticity of substitution is low relative to the trade price elasticity, higher tariffs would tend to boost output (as the expenditure-switching

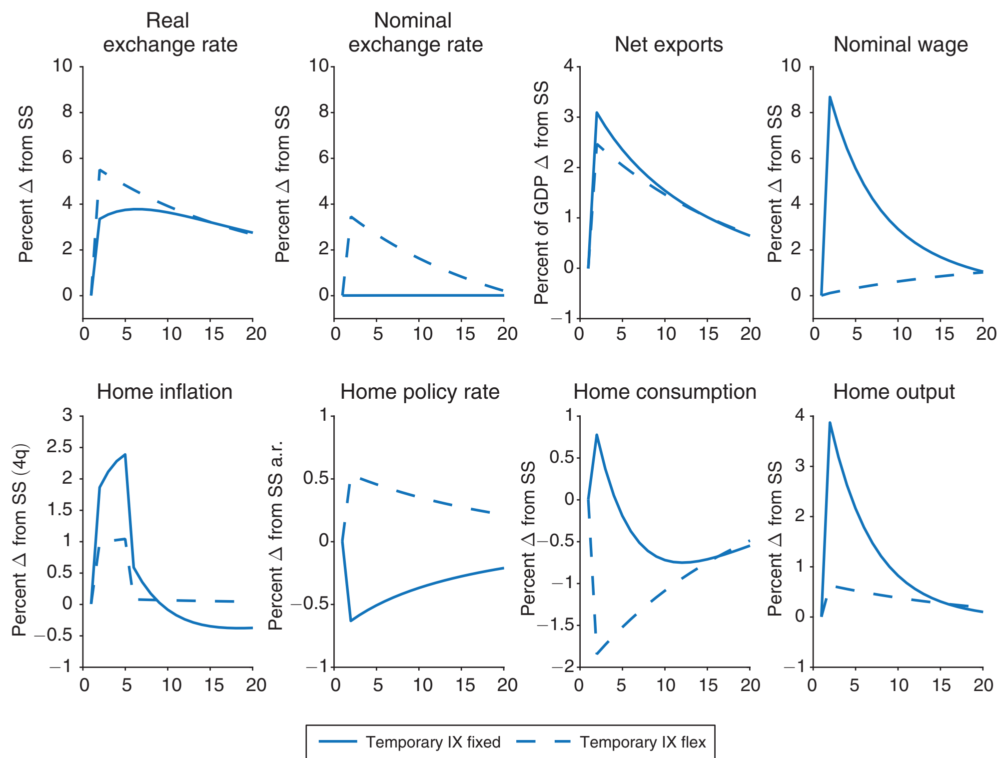

Figure 2. Macroeconomic Effects of IX with Expected Reversal Fixed versus Flex Exchange Rate Regime

Notes: In both experiments we assume that prices are sticky and wages are flexible. The solid line shows the case in which the home country pegs to the foreign country which follows a standard Taylor rule. The dashed line is the case in which the exchange rate is flexible. The figure shows the expected path of each variable after the policy is implemented and given that it is expected to be permanently abandoned with probability 0.05 as long as it is in place.

effect dominates), whereas higher tariffs would reduce output if the intertemporal elasticity is high relative to the trade elasticity. Even so, under standard calibrations for these parameters, a combination of import tariffs and export subsidies that is expected to be reversed increases output in the near term.

The magnitude of the stimulus from temporary IX policies depends on the response of monetary policy as well. For instance, a larger interest rate response to producer price inflation (higher φ_π in the policy rule) and, consequently, to the external demand stimulus would imply smaller output effects. By contrast, when monetary policy gives high weight to stabilization of the exchange rate (high φ_ε in the policy rule), the output stimulus is larger, with a fixed exchange rate regime an interesting limiting case. In this spirit, Figure 2 shows how the IX policies play out in our baseline model, in which the home exchange rate is fixed to that of the foreign economy (solid lines). Home output rises significantly more in this case than under flexible exchange rates. This larger output expansion largely reflects that consumption expands robustly—rather than contracts—as the home policy rate declines in

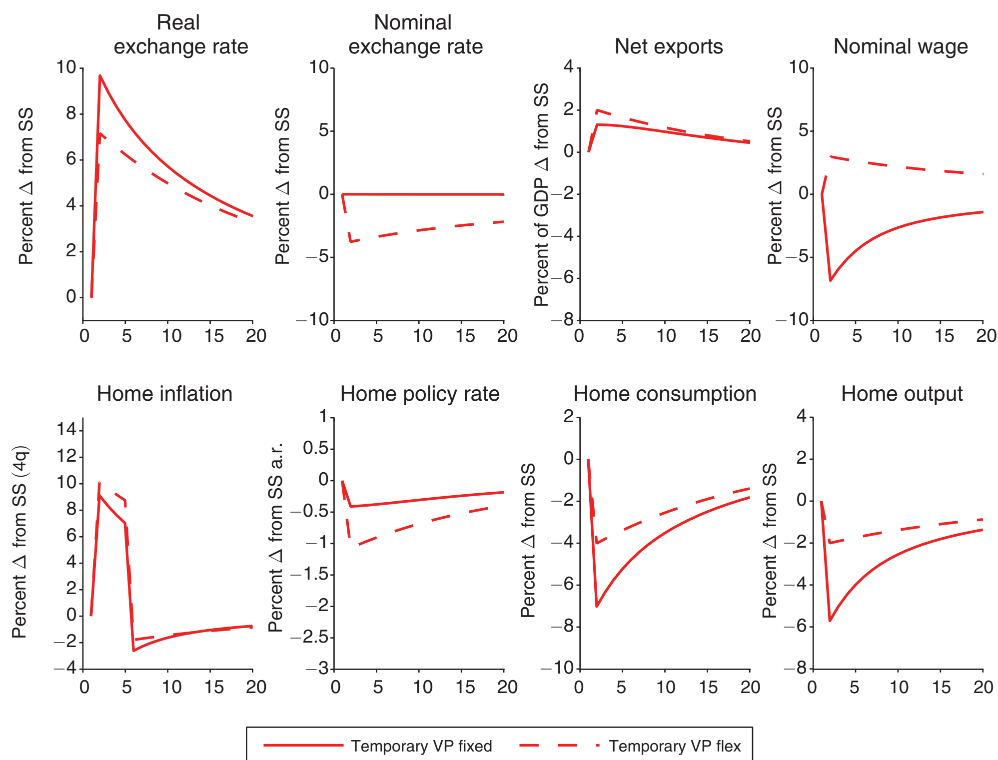

Figure 3. Macroeconomic Effects of VP with Expected Reversal Fixed versus Flex Exchange Rate Regime

Notes: In both experiments we assume that prices are sticky and wages are flexible. The solid line shows the case in which the home country pegs to the foreign country which follows a standard Taylor rule. The dashed line is the case in which the exchange rate is flexible. The figure shows the expected path of each variable after the policy is implemented and given that it is expected to be permanently abandoned with probability 0.05 as long as it is in place.

lockstep with the foreign policy rate. The rise in output is also reinforced by a larger increase in exports.

We next turn to the effects of VP policies that are expected to be reversed. As evident from equation (49), temporary VP policies have strong intertemporal substitution effects on consumption, much more so than temporary IX policies. While IX policies dampen consumption by raising import prices, VP policies exert broad-based downward pressure on the entire consumption bundle.

The contractionary effect of this intertemporal substitution channel turns out to be the most relevant quantitative force driving the macroeconomic effects of temporary VP policies. Figure 3 shows the effects of VP policies of size $\delta = 10$ percent that are reversed with probability $(1-\rho) = 0.05$ by the following quarter. The red solid line shows the case in which exchange rates are flexible, while the red dashed line shows the case in which exchange rates are fixed. In both cases the immediate increase in consumer prices causes the real exchange rate to appreciate substantially. The higher real interest rate under VP depresses aggregate demand markedly,

causing a contraction in output. When exchange rates are flexible, the central bank lowers policy rates in response to depressed economic activity, which limits the decline in consumption and causes the nominal exchange rate to depreciate, boosting net exports. The output decline is noticeably larger under fixed exchange rates given that the central bank can't lower interest rates to provide needed stimulus. While the contractionary effects of a temporary VP contrast sharply with the expansion of output under a temporary IX, the two policies have similar effects on trade quantities. This outcome, however, reflects very different channels. The IX policy has direct competitiveness-enhancing effects on relative trade prices that raise exports and cause imports to contract. This stimulus is only partially counterbalanced by a tightening of policy rates and an appreciation of the home currency. In contrast, the stimulus to net exports from the VP policy is mainly due to a decline in import demand amidst a contraction of domestic consumption (amplified by exchange rate depreciation in the case of flexible exchange rates).

Taken together, our results underscore how the different transmissions of VP and IX imply that, once the restrictive conditions in Proposition 1 are relaxed, these policies will, in general, have very different macroeconomic effects. Given the importance of intertemporal substitution channels in shaping the macroeconomic effects of a temporary VP, such a policy runs the risk of providing a contractionary impetus to output, especially if the policy interest rate and exchange rates cannot adjust much. One important caveat to this claim is that VP can in principle boost output if wages are sticky—a case to which we next turn.

B. *IX and VP Policies: The Role of Wage Rigidity*

A large macroeconomic literature assumes that households set nominal wages in Calvo-style staggered contracts that are similar in form to the price contracts outlined in Section II.[28] In addition, the appeal of competitiveness-enhancing payroll tax cuts financed with VAT increases appears greater when rigid wages prevent strong offsetting general equilibrium responses.[29]

Figure 4 shows the response of the economy to unexpected and permanent VP (solid red lines) and IX (dashed blue lines) policies under fixed exchange rates and sticky wages.[30] The IX policy implements the same allocation as a once and for all 10-percent currency devaluation. The direct stimulative effects of net exports are greatly amplified by an accomodative monetary policy response which, under a peg, mimics the declines in interest rate implemented by the foreign economy. The resulting increase in domestic demand causes output to increase substantially.

The permanent VP policy provides modest stimulus through the competitive enhancing effects of payroll subsidies. With sticky wage adjustment, the employer payroll subsidy persistently reduces producers' marginal costs. As supply slowly

[28] See, for instance, Erceg, Henderson, and Levin (2000).

[29] For instance, the quantitative analysis in FGI suggests that an appropriately calibrated VP policy would have allowed the Spanish economy to suffer almost no employment and output losses in 2008-09, largely by correcting the macroeconomic instability introduced by rigid wages.

[30] We choose the parameter controlling the degree of wage stickiness to imply that wages are adjusted with the same frequency as prices.

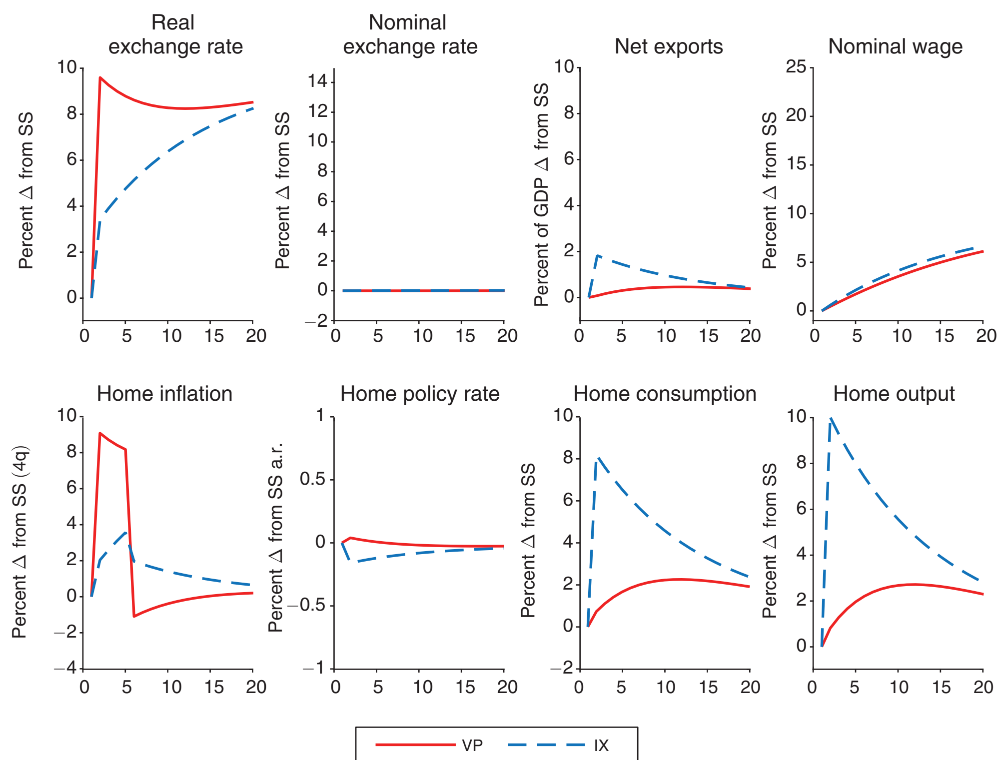

Figure 4. Permanent IX and VP with Sticky Wages and Fixed Exchange Rates

Notes: In both experiments we assume that prices and wages are sticky and the exchange rate is flexible. The solid line shows the response to VP and the dashed line the response to IX. In both cases the policies are (expected to be) permanent.

expands in response to the enhanced competitiveness, output and consumption rise, and exports expand. However, the rise in domestic demand is only modest, and the boost to net exports is muted by a large real exchange rate appreciation. Critically, the stimulus from VP hinges on the policy change being perceived as permanent or at least very highly persistent. Intertemporal substitution effects dominate if agents see a material chance of reversal, and VP causes output to contract.

IV. A Quantitative Assessment of Fiscal Devaluations

In this section, we consider the 2007 fiscal policy reform in Germany as a laboratory to study the extent to which VP and IX policies can, quantitatively, provide as much stimulus as a currency devaluation. We use a medium-scale version of our baseline model to study whether this fiscal reform can account for the economic underperformance of Germany in 2007. We estimate the degree of pass-through of VAT changes and the perceived persistence of the policy change so that they minimize the distance between the German data on output and inflation and the corresponding model simulated series. We then perform a counterfactual experiment

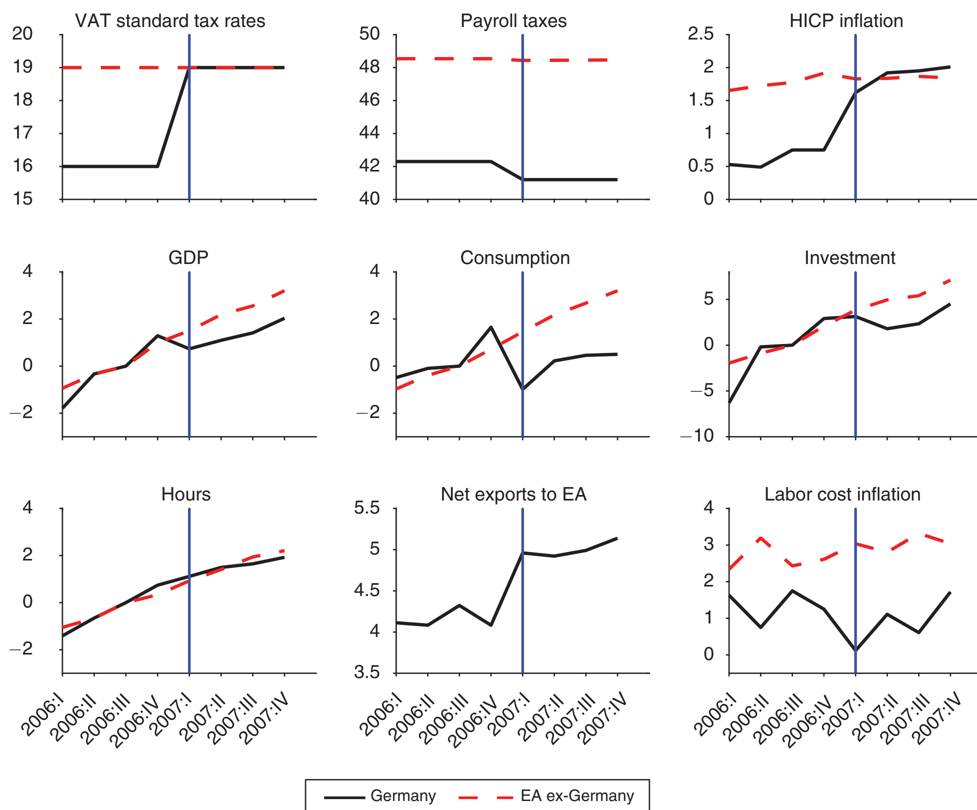

Figure 5. 2007 German VP: Data

Notes: Macroeconomic data for Germany and the euro area (EA) are from Haver (EU Database). See online Appendix for details. Consumption, investment, and GDP are normalized to equal one in 2006:III. To be consistent with our model, we show net exports from Germany to the other EA countries. Accordingly, GDP excludes trade with the rest of the world both for Germany and for EA ex-Germany.

under the estimated parameters to determine whether IX could have been a more effective substitute for a currency devaluation.

A. *Data*

In 2006 the German government announced its intentions to increase fiscal revenues through a VAT hike and boost competitiveness by cutting payroll taxes. The details of these tax shifts were finalized over the course of 2006 and went into effect starting January 2007.

Figure 5 presents the evolution of key macroeconomic variables in Germany and other euro-area economies in the years 2006 and 2007. In January 2007, the standard VAT rate in Germany increased from 16 percent to 19 percent.[31] The increase in the VAT rate affected about half of the bundle of goods included in the consumer

[31] The reduced VAT rate remained unchanged at 7 percent. A number of services, including those for nonprofit organizations and services provided directly by the government, are exempt from the VAT.

price index, resulting in an average VAT increase of about 1.4 percent.[32] At the same time, payroll taxes declined more than 1 percent (black lines in the first and second panels). Notably, VAT and payroll taxes remained stable in the rest of the euro area (dashed red lines). Hence, the 2007 VP reform in Germany can be viewed as broadly akin to a fiscal devaluation by a currency union member. In what follows we use the time series evidence in Figure 5 as a direct measure of the effects of VAT and payroll tax changes on the German economy. That is, we attribute the difference between the performance of the German economy and other euro-area economies over the 2006:I–2007:IV period to the implementation of this fiscal reform. Two considerations support this assumption. First, the historical narrative indicates that these tax changes were the most important economic development in Germany during this period.[33] Second, the stable performance of the remaining euro-area economies over this period seems to be inconsistent with the hypothesis that a common macroeconomic shock had disproportionately larger effects in Germany than in other countries.[34]

The German VP failed to elicit the boost in economic activity typically associated with a currency devaluation. As shown in Figure 5, the implementation of this VP policy produced two main effects on the German economy. First, consumer prices increased markedly in the first quarter of 2007, when the VAT rate increase went into effect. Second, barring some pulling forward of aggregate demand in anticipation of the VAT hike, economic activity in Germany underperformed relative to its euro-area counterparts. In 2007, consumption growth in Germany was negative, investment was weak, and, despite a boost to net exports, GDP growth remained significantly below that in the euro area.[35,36]

B. *The Extended Model*

We next extend our baseline model along several dimensions to study the observed economic effects of the 2007 German VP policy within the euro area. First, we model the monetary policy framework of the European Central Bank (ECB) via an

[32] We are implicitly assuming that the goods affected by and those excluded from the tax increases feature very limited substitutability, at least in the short run, and similar aggregate demand and supply schedules. A richer multisector model with empirically realistic assumptions on the industry level elasticities of substitution, demand, and supply, would be needed to gauge the quantitative plausibility of this assumption. That said, the sizeable observed effects of the policy on economic activity suggest that substitutability between affected and excluded categories was indeed limited.

[33] See, e.g, Bundesbank (2007) and D'Acunto, Hoang, and Weber (2016). In 2007 government expenditure in Germany grew less than in the rest of Europe. However, the difference was small and cannot plausibly account for the observed behavior of German aggregate demand. We discuss this in the online Appendix.

[34] Our focus on a narrow time window around the implementation of the VP policy minimizes the possible confounding effects of reforms that had happened in Germany earlier. Notably, between 2003 and 2005, the German government implemented a series of labor market reforms, the Hartz reforms, which addressed structural weaknesses in the German labor market. Existing studies suggest that most of the effects of the Hartz reforms materialized before the end of 2006. See for instance Krause and Uhlig (2012). Moreover, these types of reforms tend to have stimulative effects on economic activity—see for instance Chodorow-Reich, Coglianese, and Karabarbounis (2019)—so they would not go in the same direction of the effect of VP predicted by our model.

[35] The Eurostat measure of consumption for European economies includes nondurable goods, durable goods, and services. Much of the initial increase and subsequent decline in German consumption is due to changes in durable goods, such as motor vehicle purchases, for which there is evidence of nearly full pass-through of the VAT increase. See Erceg, Prestipino, and Raffo (2018) and D'Acunto, Hoang, and Weber (2016) for further discussion.

[36] See the online Appendix for a detailed description of how the data is constructed.

inertial Taylor rule that responds to an average measure of consumer price inflation and the output gap within the currency union, with the home country representing Germany (H) and the foreign country representing an aggregate of all other euro-area economies (F). Monetary policy is described by the rule

$$\left(\frac{R_t^{EA}}{\bar{R}}\right) = \left(\frac{R_{t-1}^{EA}}{\bar{R}}\right)^{\rho_R} \left(\pi_t^s \pi_t^{*1-s}\right)^{\varphi_\pi} \left(\tilde{y}_t^s, \tilde{y}_t^{*1-s}\right)^{\varphi_y}, \tag{53}$$

where $\left(R_t^{EA}\right)$ is the euro-area policy rate, ρ_R is the interest-smoothing parameter, and s denotes the normalized size of the home country (Germany).[37]

Second, we introduce capital as an additional input in the production function and allow households to optimally adjust its utilization:

$$Y_t = u_t K_t^{\alpha} L_t^{1-\alpha}, \tag{54}$$

where u_t is capital utilization, K_t is the physical capital stock, and L_t is the aggregate labor input consisting of differentiated labor services supplied by households. There are convex costs of varying capital utilization from its steady state level of unity which are given by

$$\frac{r^k}{\sigma_u}\left\{\exp\left[\sigma_u\left(u_t - 1\right)\right] - 1\right\}, \tag{55}$$

where r^k is the steady state rental rate of capital, and σ_u measures the inverse elasticity of utilization to variation in the rental rate of capital.[38]

We also assume that capital accumulation is subject to adjustment costs. The law of motion of capital is

$$I_t = K_{t+1} - \left(1 - \delta_K\right)K_t + \frac{\kappa}{2}\left[\frac{K_{t+1} - \left(1 - \delta_K\right)K_t}{\delta_K K_t} - 1\right]^2 K_t, \tag{56}$$

where I_t is investment in final goods, δ_K is the depreciation rate, and κ is the parameter governing the curvature of the cost of adjusting capital.

Third, given the large body of evidence in support of wage rigidity and its importance for the macroeconomic effects of VP policies, we consider sticky wages. As in Erceg, Henderson, and Levin (2000), we assume that monopolistically competitive households supply labor services that are considered imperfect substitutes by the production sector. Taking labor demand as given, households set nominal wages in

[37] Note that in equation (53), the policy rate responds to consumer price inflation in the euro area, rather than domestic goods inflation $\pi_{P,t}$, and hence reacts to VAT changes. Our results are robust to an alternative specification for monetary policy which sees through VAT changes as in equation (36).

[38] This specification follows Christiano, Eichenbaum, and Evans (2005). See the online Appendix for details.

staggered contracts that are analogous to the price contracts described for producers. These assumptions yield the conditions

$$\bar{W}_t = E_t \sum_{s \geq t} \tilde{\Lambda}_{t,s}^{W}(i) \frac{\gamma_W}{\gamma_W - 1} \frac{n_s(i)^{\eta}}{C_s^{-\sigma}}, \tag{57}$$

$$\frac{W_t}{W_{t-1}} = \left[\zeta_W + (1 - \zeta_W)\left(\frac{\bar{W}_t}{W_{t-1}}\right)^{1-\gamma_W}\right]^{\frac{1}{1-\gamma_W}}, \tag{58}$$

determining the optimal reset wage $\bar{W}_t$ and the evolution of wages, which jointly imply a standard wage Phillips curve. The parameter ζ_W is the probability that the household will not be able to adjust its wage in a given period, and γ_W governs the elasticity of substitution across labor services.[39]

Finally, we introduce heterogeneity in the price response to VAT changes. We assume that firms in the set $\mathcal{F}$ of measure μ fully pass through VAT changes as in our baseline model (described above). For the remaining proportion $1 - \mu$ of firms in the set $\mathcal{I}$, we assume that prices are sticky inclusive of taxes and thus the pass-through is incomplete, as in FGI. Hence, the price indexes for the two sets of firms are

$$P_{P,t}^{\mathcal{F}} = \left[\zeta_P \left(P_{P,t-1}^{\mathcal{F}}\right)^{1-\gamma} + (1 - \zeta_P)\left(\bar{P}_{P,t}^{\mathcal{F}}\right)^{1-\gamma}\right]^{\frac{1}{1-\gamma}}, \tag{59}$$

$$P_{P,t}^{\mathcal{I}} = (1 - \tau_t^v)\left[\zeta_P \left(\frac{P_{P,t-1}^{\mathcal{I}}}{1 - \tau_{t-1}^v}\right)^{1-\gamma} + (1 - \zeta_P)\left(\bar{P}_{H,t}^{\mathcal{I}}\right)^{1-\gamma}\right]^{\frac{1}{1-\gamma}}. \tag{60}$$

Equation (60) shows that, for firms in the set $\mathcal{I}$ that do not adjust their price, an increase in the VAT causes producer prices, and hence margins, to drop mechanically. The overall response of average prices for firms in $\mathcal{I}$ will then depend on the endogenous response of optimizing firms that reset consumer prices $\bar{P}_{H,t}^{\mathcal{I}}$

Domestic producer price inflation in the home country is approximately given by the weighted average of the inflation rates of the two sets of firms:

$$\pi_{P,t} \approx \mu \pi_{P,t}^{\mathcal{F}} + (1 - \mu)\pi_{P,t}^{\mathcal{I}}. \tag{61}$$

C. *Parameter Values*

Table 2 presents the parameter values used in our quantitative analysis. We partition the model parameters in two sets. The first includes conventional parameters that are either fixed to standard values commonly used in the literature or calibrated using German data. We set the discount factor β to 0.99; the coefficient of relative risk aversion σ to unity; the elasticities of substitution among good varieties γ and

[39] See the online Appendix for details.

Table 2—Parameter Values for the Extended Model

	Parameter	Value
Calibrated Parameters		
Discount factor	β	0.99
Risk aversion	σ	1.00
Frisch elasticity of labor supply	η^{-1}	1.00
Good variety elasticity	γ	11.0
Labor variety elasticity	γ_W	6.0
Price stickiness	ζ_P	0.85
Wage stickiness	ζ_W	0.85
Trade elasticity	θ	1.25
Import share	$1-\omega_H$	0.15
Labor share	α	0.64
Capital depreciation rate	δ_K	0.025
Capital adjustment cost	κ	10
Inverse Elasticity of Utilization	σ_u	0.01
Country size	s	0.25
Inertia in the Taylor rule	ρ_R	0.85
Output gap weight in the Taylor rule	φ_y	0.125
Inflation weight in the Taylor rule	φ_π	1.50
Estimated Parameters		
Complete pass-through	μ	0.60
Persistence	ρ	0.93

among labor varieties γ_W to 11 and 6, respectively; the labor share α to 0.64; and the capital depreciation rate δ_K to 0.025. In addition, we set the coefficient controlling inertia in the monetary policy response ρ_R to 0.85, and the coefficients controlling the response to inflation and the output gap, φ_π and φ_y, to 1.5 and 0.125, respectively. These values are all fairly conventional. We then calibrate the size of the home country and the import share to match the share of German GDP in the euro area and the average value of goods and services imported from other euro-area countries relative to German GDP between 2000 and 2006. The resulting parameter values are $s = 0.25$ and $1-\omega_H = 0.15$.

We set the Frisch elasticity of labor supply, η^{-1}, equal to 1, in the middle of the range of estimates. For the value of the elasticity of substitution between domestic and foreign goods, θ, we choose a value of 1.25, based on the evidence discussed in FGI and Imbs et al. (2010). The Calvo parameters controlling price and wage stickiness, ζ_P and ζ_W, are both set to 0.85, consistent with the evidence for euro-area countries discussed in Galí and Monacelli (2016). We calibrate the curvature of the capital adjustment cost function to 10, in the middle of the range of estimates that go from more than 20 (Hayashi 1982) to as low as 2 (Cao, Lorenzoni, and Walentin 2019). Finally we set the inverse elasticity of capital utilization, σ_u, to 0.01, as in Christiano, Eichenbaum, and Evans (2005).

The finite-state Markov chain that controls the evolution of tax instruments is calibrated to the German fiscal devaluation. In particular, VATs and payroll subsidies are a function of the Markov state s_t, $\tau_t^v = \psi_\tau(s)$ and $\varsigma_t^p = \psi_\sigma(s)$, where $s_t \in S = \{\bar{s}_1, \bar{s}_2, \bar{s}_3\}$. The transition probability matrix is given by

$$T = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ (1-\rho) & 0 & \rho \end{bmatrix}, \tag{62}$$

where the element in the ith row of the jth column of T measures the probability of moving from state i to state j. The first state is the steady state with no taxes $\psi_\tau(\bar{s}_1) = \psi_\sigma(\bar{s}_1) = 0$. In the second state, taxes are still not implemented, $\psi_\tau(\bar{s}_1) = \psi_\sigma(\bar{s}_1) = 0$, but they are announced for the following quarter, $\Pr(s_{t+1} = \bar{s}_3 \mid s_t = \bar{s}_1) = 1$. In the third state, the VP policy is implemented, $\psi_\tau(\bar{s}_1) = \tau^V$ and $\psi_\varsigma(\bar{s}_1) = \varsigma^P$. The third row of matrix T indicates that $1 - \rho$ measures the probability that the policy is reversed and fiscal policy returns to the steady state. We set $\tau^V = 1.45$ percent and $\varsigma^P = 1.25$ percent, consistent with the fiscal measures implemented by the German government in 2007.

The second set of parameters, which includes the fraction of firms that fully pass VAT changes through to consumer prices (μ) and the parameters that control the evolution of VATs and payroll subsidies (ρ), is estimated. Given the importance of these parameters for the macroeconomic effects of VP policies, we set $\Theta = [\mu;\rho]$ so that it minimizes the distance between the German data on output and inflation presented in Figure 5 and the corresponding model-implied series. In particular, we denote by $M_D = \left\{ \left\{\tilde{\pi}_t^D\right\}_{t=t_0}^T, \left\{\tilde{y}_t^D\right\}_{t=t_0}^T \right\}$, with $t_0 = 2006{:}\text{IV}$ and $T = 2007{:}\text{IV}$, the vector containing data on German output and consumer price inflation in deviation from the euro-area data on output and inflation between 2006:IV and 2007:IV. Similarly, we let $M_M(\Theta) = \left\{ \left\{\tilde{\pi}_t^M\right\}_{t=t_0}^T, \left\{\tilde{y}_t^M\right\}_{t=t_0}^T \right\}$ denote the corresponding vector of model-simulated series obtained under a specific vector of parameter Θ, conditional on the calibrated values of all other parameters discussed earlier, including the size of the policy innovations.[40] We assume that in 2006:III, the model economy is in the steady state, $s_t = \bar{s}_1$ for $t = 2006{:}\text{III}$. The policy is then announced in 2006:IV, and agents expect it to be implemented in the following quarter, $s_t = \bar{s}_2$ for $t = 2006{:}\text{IV}$. The policy is implemented in 2007:I and remains in effect throughout 2007, although agents give positive probability, $1 - \rho$, to a reversal. That is, for $t \in \{2007{:}\text{I}, 2007{:}\text{II}, 2007{:}\text{III}, 2007{:}\text{IV}\}$, $s_t = \bar{s}_2$ so that in 2007:I τ_t^V increases 1.45 percent and ς_t^P increases 1.25 percent, and they remain at the higher level throughout 2007 as in the data. We then choose Θ to solve

$$(63) \qquad \Theta^* = \arg\max \mathcal{O}(\Theta) = \arg\max - \left[M_D - M_M(\Theta)\right]'\left[M_D - M_M(\Theta)\right].$$

The objective function is maximized at the point $\Theta^* = [0.6; 0.93]$. These values suggest that, in order to account for the price increase and output decline observed in the data, the model requires a significant fraction of firms passing VAT changes through to consumer prices $(\mu = 0.6)$ and a positive probability of policy reversal $(1 - \rho = 0.07)$. While the large estimated share of firms passing through VAT changes to prices is obtained purely from aggregate data, it is also in line with the heterogenous pricing response across sectors documented in Bundesbank (2007). For instance, the pass-through during the first quarter of 2007 was full in the automotive sector but muted in the retail sector. Similarly, an expected duration of the

[40] Given the small GDP share of the home country, spillovers to the foreign country are quantitatively negligible in the model, as in the data. Hence, we include in $M_M(\Theta)$ the model response of the German economy in deviation from the steady state, which will facilitate the economic interpretation of our simulations. The effects on the other euro-area economies are shown in the online Appendix.

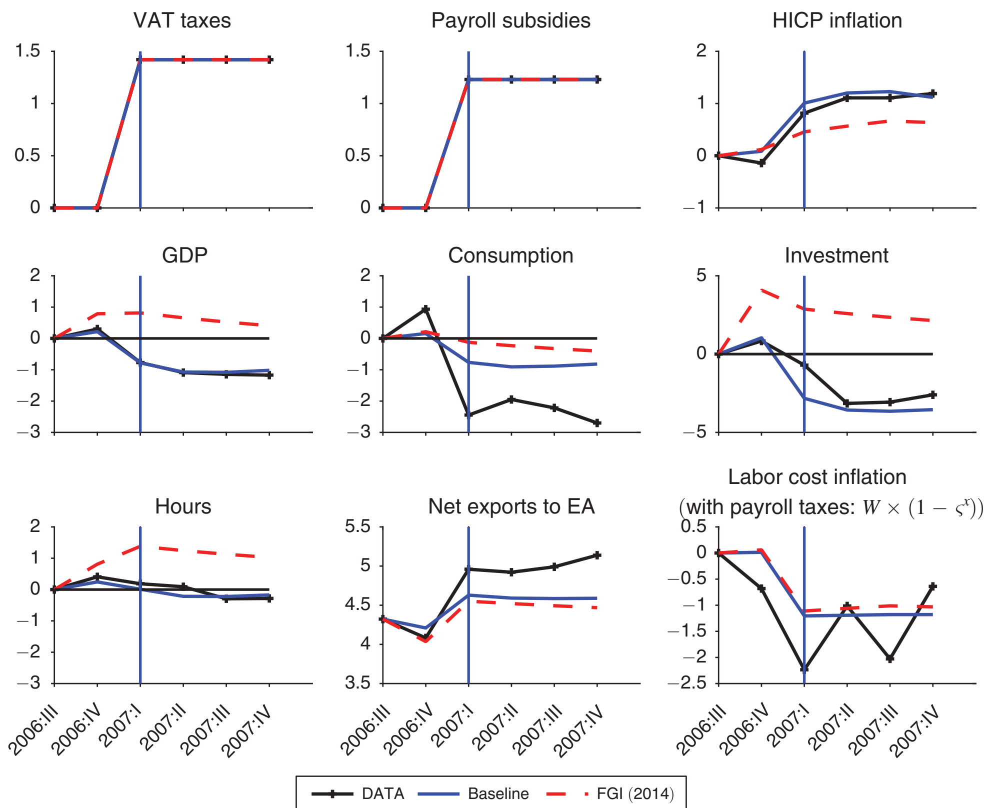

Figure 6. 2007 German VP, Model versus Data

Notes: For all variables except net exports, the data line (black crossed) shows the difference between the variable in Germany and in the EA ex-Germany, i.e., the difference between the black solid line and the red dotted line in Figure 5. The model lines show the response in the home country in deviation from steady state to a VP policy announced in 2006:IV and implemented in 2007:I. HICP and wage inflation are four-quarter percent changes. Net exports are in percent of GDP. The other variables are percent deviations from steady state. The blue solid line assumes $\mu = \mu^* = 0.6$ and $\rho = \rho^* = 0.93$. The dashed red line assumes $\mu = 0$ and $\rho = 1$.

policy of about eight years, as implied by our estimated value of ρ, is consistent with reasonable assumptions about the likelihood of political turnover and its implications for the evolution of fiscal policy.[41] As discussed in the online Appendix, the limiting assumption of permanent policy changes $(1 - \rho = 0)$ and all prices sticky inclusive of VATs $(\mu = 0)$, typically adopted in the fiscal devaluation literature, appears to be strongly rejected by the data.

[41] As noted in D'Acunto, Hoang, and Weber (2016), at the time there was severe disagreement between the two main parties on the benefit of the VP policy and, thus, uncertainty about the duration of the policy in case of a change in government.

D. *Model versus Data*

Figure 6 compares the response of the German economy to an announced VP policy in our model and in the data. For each variable except net exports, the data lines present German variables relative to their euro-area counterparts. The model lines show the response in the home country in deviation from the steady state. In particular, the solid blue line shows our "Baseline" experiment constructed using our estimated values $(\mu^*, \rho^*) = (0.6, 0.93)$. The dashed red line shows the response of the economy in the case of a "quasi" fiscal devaluation as in FGI, which we capture by assuming that there is no pass-through of VAT changes ($\mu = 0$) and that the policy is known to be permanent ($1 - \rho = 0$).[42] As the first two panels show, in our baseline experiment, even though agents give positive probability to a reversal, the policy remains in effect throughout 2007.

Our baseline experiment reproduces, both qualitatively and quantitatively, the evolution of German macroeconomic data. First, the model reproduces well the behavior of output and inflation. While these series were targeted in the estimation of (μ^*, ρ^*), this estimation was conditional on the calibrated values of all other parameters, including the size of the policy changes, and the assumption that VP was the only shock hitting the German economy. Second, it is quite remarkable how well the model captures the behavior of other macroeconomic data not targeted in the estimation. Both consumption and investment increase upon announcement of the tax changes, as agents substitute away from future expenditures in anticipation of higher prices. When the policy is implemented, consumption and investment drop as the transitory increase in intertemporal prices due to the dynamics of the VAT changes more than offsets the stimulative effects of the payroll subsidy.[43] One key channel that allows the model to replicate the behavior of investment is variable capital utilization, which dampens fluctuations in the rental rate of capital and thus implies that investment is largely determined by the real interest rate. Variable capital utilization also helps the model match the behavior of labor input as variation in utilization accounts for most of the variation in output in response to these tax changes. Consequently, labor input is only slightly affected, in line with the data. Similarly, the model reproduces very well the increase in net exports and the overall evolution of wages.

In contrast, the VP policy under the FGI assumptions generates a boom in aggregate demand and output that appears at odds with the data. Given that the policy is expected to be permanent, VAT changes do not directly distort intertemporal prices in this case. In addition, as all prices are assumed to be sticky inclusive of VATs, there is no pass-through of VAT changes to consumer prices in the short run and aggregate demand increases on impact. The increase in VAT mechanically induces

[42] As explained in FGI, this VP policy would only approximate a currency devaluation for three reasons: First, a devaluation would require a capital subsidy. Second, monetary policy for the currency union responds to developments in the home country. Third, in our calibrated experiment, the change in the VAT is slightly different from the change in the payroll subsidy. That said, their analysis suggests that this policy would still provide significant macroeconomic stimulus, as confirmed by our experiment.

[43] As argued by Galí and Monacelli (2016), temporary payroll tax reductions are much less effective in stimulating economic activity under a fixed exchange rate regime.

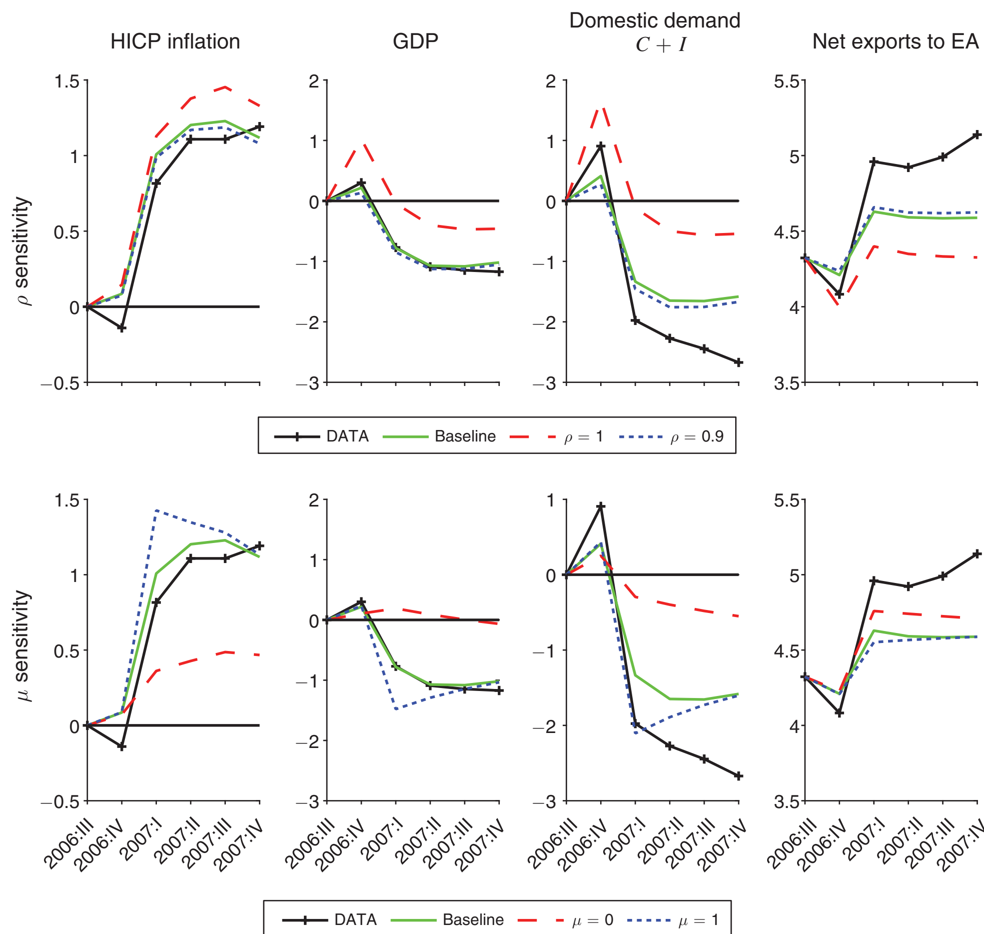

Figure 7. Expectations of Policy Reversal and Tax Pass-Through under VP

Notes: The data line (black crossed) and the baseline (blue solid) are as in Figure 6. In the first row $\mu = \mu^*$, the dashed red line assumes $\rho = 1$, and the dotted green line assumes $\rho = \rho^* = 0.1$ probability in the following quarter. In the second row $\rho = \rho^*$, the dashed red line assumes incomplete pass-through for all firms, and the dotted green line assumes complete pass-through for all firms.

a reduction in producer prices for firms that cannot adjust, thus boosting external competitiveness. These forces produce a counterfactually large and persistent boom in output and its components as well as labor input. Of note, the increase in prices in 2007:I is largely driven by the mechanical increase in import prices induced by the VAT increase.[44]

Figure 7 describes how the parameters controlling VAT pass-through and expected policy reversal each help the baseline experiment account for the German data. The red dashed lines in the first row of Figure 7 show that even under our estimated value of VAT pass-through (μ^*), a permanent VP policy provides a large boost to

[44] Irrespective of the value of μ, the pass-through of VAT changes into import prices is full and complete.

investment and employment, as the intertemporal substitution effect is absent when the policy is expected to remain in place forever. As noted earlier, the relationship between the economic effects of VP and variations in ρ appears highly nonlinear: when the persistence of the policy is decreased to 0.9, the dotted light-green lines, the macroeconomic effects of the policy are essentially identical to those under the baseline estimated value of $\rho^* = 0.93$. Similarly, the dashed red lines in the second row of Figure 7 show that, when prices are sticky inclusive of taxes for all firms $(\mu = 0)$, the intertemporal substitution effects are muted even under policy reversal, as VATs are slow to show through in consumer prices. As a result, domestic demand falls much less. Moreover, the boost to international competitiveness induced by higher VATs under incomplete pass-through leads to a larger increase in net exports, leaving output little changed. In contrast, when all firms fully pass through VAT increases, the dotted light-green lines show that the macroeconomic effects of VP are broadly similar to our baseline effects, apart from the larger immediate increase in consumer prices that is offset by subsequent declines. All told, both a substantial share of firms that fully passes through VAT increases and a non-negligible probability of future policy reversal appear to be necessary in order for the model to match the observed performance of the German economy.

E. *IX*, *VP*, *and Currency Devaluations*

We now reinterpret the effects of the 2007 fiscal reform in Germany through the lens of our theoretical analysis of fiscal devaluations in Sections II and III. In particular, we use our extended model to ask two questions. First, what would have been the effects on the German economy of a currency devaluation against other euro-area countries? Second, could the German government have achieved outcomes similar to a devaluation even within a currency union by implementing an IX policy rather than a VP policy? While Germany's euro-area membership would preclude it from pursuing such policies, it is interesting to assess whether they would be more effective than VP if they were in fact viable policy options.

The experiments depicted in Figure 8 address these two questions by studying the effects of a currency devaluation (blue solid line) and an IX policy (red dashed line). In the currency devaluation experiments, we assume that the German economy pegs its interest rate to the ECB policy rate, which is set according to a standard Taylor that responds to CPI inflation and the output gap in the EA ex-Germany bloc. The panels in the first row depict the response of the economy when the policies are expected to be permanent, while those in the second row assume that all policies are expected to be reversed. As in the VP experiment above, the probability of reversal in the following quarter is 0.07 and the size of the tax changes is 1.23 percent. For simplicity, and differently from before, we assume that the policies are unanticipated.

Figure 8 shows that a currency devaluation provides substantial stimulus to the economy irrespective of whether or not it is expected to be reversed. In both cases, the direct boost to exports is amplified by an expansion in domestic demand caused by a persistent decline in real interest rates. When the devaluation is expected to be permanent, the expected inflationary effects of the policy cause a decline in real rates with the policy rate almost unchanged. When devaluation is expected to be

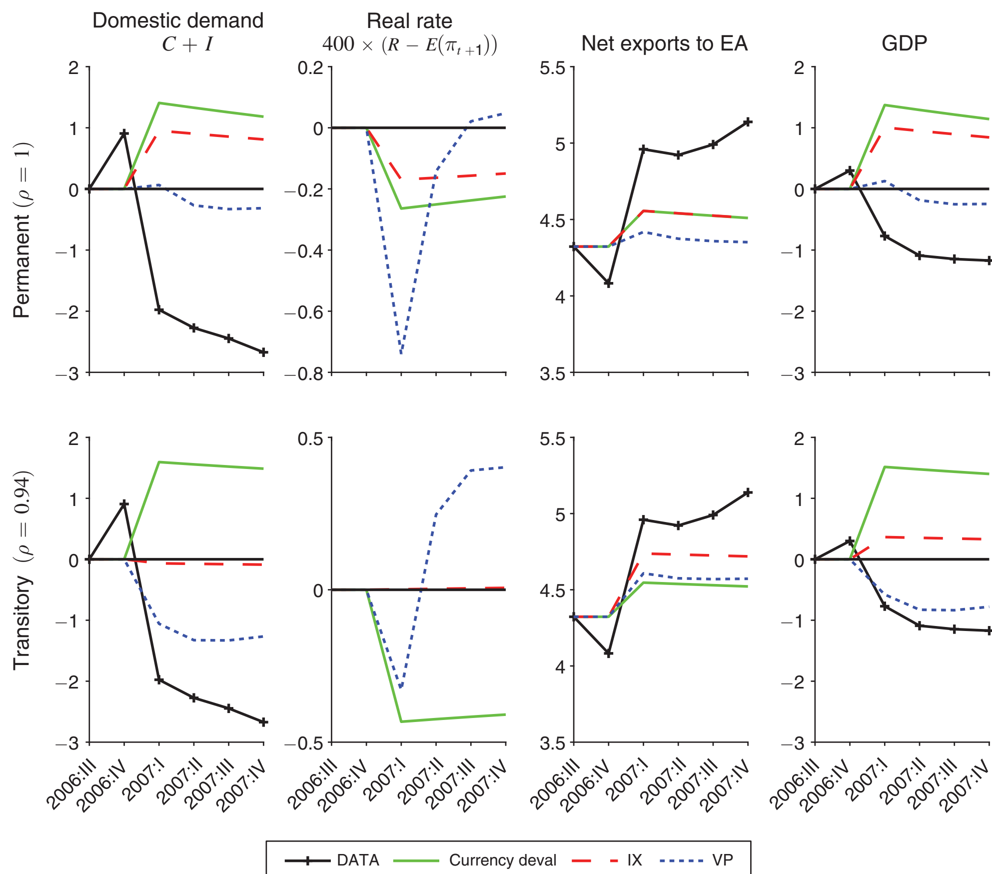

Figure 8. VP, IX, and Currency Devaluations

Notes: The data lines (black crossed) are as in Figure 6. The dashed red lines refer to permanent (top row) and transitory (bottom row) IX policies. The dotted blue lines refer to permanent (top row) and transitory (bottom row) VP. The solid green lines refer to permanent (top row) and transitory (bottom row) currency devaluations. All experiments assume assume $\mu = \mu^*$, and the transitory experiments assume $\rho = \rho^*$.

reversed, the inflationary effects are dampened, given that a reversal eventually causes inflation to decline. That said, given that agents expect the currency to eventually appreciate back to steady state, the policy rate has to fall below the foreign policy rate in order to implement the same size devaluation. As a result, the boost to domestic demand and output is somewhat larger when the currency devaluation is expected to be temporary.[45]

The figure also shows that an IX policy within a currency union could deliver stimulus akin to a currency devaluation, provided that it is permanent. While IX is not exactly identical to a currency devaluation, as we assume that the ECB gives positive weights to inflation and output dynamics in Germany, the responses shown in the first

[45] Notice that we plot short-term real interest rate, while aggregate demand depends on the expected sum of all future interest rates which is smaller in the case of the transitory experiment.

row are quantitatively very close.[46] In contrast, when IX is expected to be reversed, its stimulative effects on domestic demand vanish. In this case, the ECB policy rate remains unchanged in response to the German IX policy, which has offsetting effects in the two blocs. As a result, the eventual reversal of IX is sufficient to neutralize the intertemporal substitution effects caused by higher expected inflation in the short run.

All told, these results confirm our theoretical prediction that IX could be a useful cyclical tool for boosting economic activity by inducing an expansion in net exports. Its effects on domestic demand, however, are much more sensitive to expectations about future policy reversal than a currency devaluation, as a currency devaluation would be accompanied by an accommodative monetary policy response.

V. Concluding Remarks

Existing literature suggests that a uniform increase in import tariffs and export subsidies (IX) and an increase in value-added taxes accompanied by a payroll tax deduction (VP) are equivalent, are neutral under flexible exchange rates, and can provide as much stimulus as a currency devaluation under fixed exchange rates. These results are particularly relevant for countries constrained by membership in a currency union. In 2007, the German government implemented a fiscal reform along these lines, as "shifting the tax burden from direct taxation and fiscal charges to indirect taxation … are elements of a revenue structure that is both more conducive to growth and more competitive."[47]

In this paper, we question this conventional wisdom. First, we argue that the transmission of IX and VP policies is fundamentally different under the assumption of full pass-through of taxes. Indeed, in a special case often considered in the literature, we show that under fixed exchange rates, IX implements a currency devaluation, whereas VP turns out to have no allocative effects. Second, we find that IX policies that are expected to be reversed or trigger retaliation tend to boost output even under flexible exchange rates. The macroeconomic effects of VP, instead, are ambiguous and depend critically on the relative strength of two offsetting channels. On the one hand, intertemporal substitution effects make VP contractionary, especially in a currency union. On the other hand, sluggish wage adjustments allow payroll subsidies to boost aggregate supply and output. Third, we assess the empirical relevance of our novel theoretical predictions about these policies by studying the effects of the 2007 German fiscal reform. We find that a canonical DSGE model of a currency union can account for the underperformance of the German economy in the aftermath of this attempted fiscal devaluation. In order for the model to fit the data, it is essential that a large share of firms fully passes VAT increases through to consumer prices and that the policy is expected to be eventually reversed with positive probability. In contrast, the limiting assumption of limited tax pass-through and permanent policy changes, typically adopted in the fiscal devaluation literature, appears strongly rejected by the data. An IX policy would have delivered an output boost through its effects on external competitiveness. That said, when expected to

[46] This argument is developed in Farhi, Gopinath, and Itskhoki (2014).
[47] See Germany SPG (2007).

be reversed, IX has only a muted effect on aggregate demand and hence provides a much smaller boost to output than a currency devaluation. All told, our analysis provides some caveats on the practical viability of fiscal devaluations as a tool to supply macroeconomic stimulus in a currency union.

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