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Fiscal Devaluation in a Monetary Union

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Given that exchange rate devaluations are no longer available in a monetary union, fiscal devaluations are one potential way to address divergence in competitiveness and trade imbalances. Employing a DSGE model calibrated to the euro area, we quantify the international effects of a fiscal devaluation implemented as a revenue-neutral shift from employers' social contributions to the value added tax. We find that a fiscal devaluation carried out in the South has a strong positive effect on output, which is five times larger than under a wage tax cut. However, the effect on the trade balance and the real exchange rate is mild. The negative effect on the North's output is weak. [JEL E32, E62, F32, F41]
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Introduction

Between 1999 and the onset of the economic crisis in 2008, real exchange rates in various countries, such as Greece, Ireland, Italy, Portugal, and Spain, have appreciated relative to the rest of the euro area (see Figure 1). This divergence in competitiveness was reflected in the emergence of external imbalances within the euro area, with some countries—such as Austria, Belgium,

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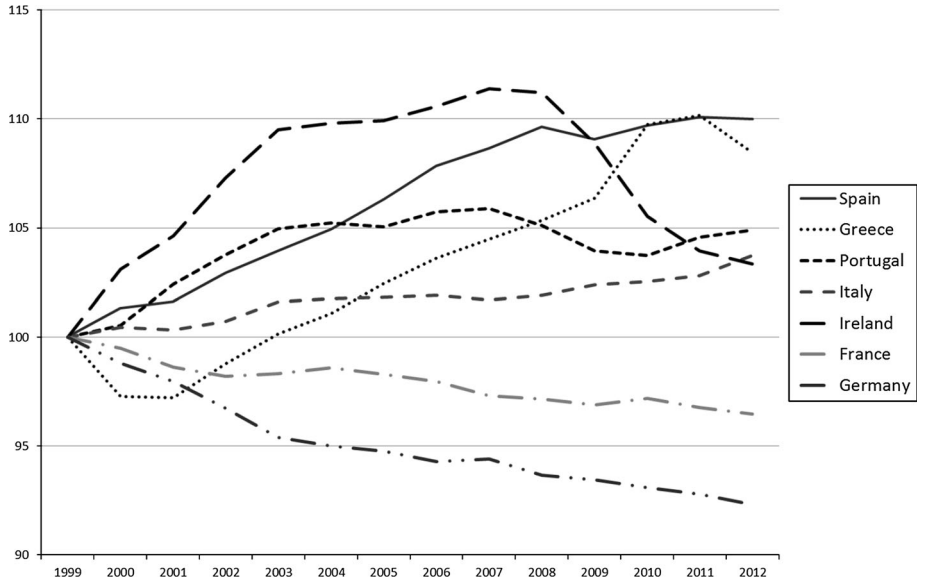
Figure 1. Real Effective Exchange Rate (deflator: consumer price indices—17 trading partners) in Selected Euro Area Countries (An increase denotes an appreciation of the real exchange rate)



Source: Eurostat (2013).

Finland, Germany, Luxemburg, and The Netherlands—accumulating current account surpluses, and others—such as Greece, Ireland, Italy, Portugal, and Spain—accumulating deficits. Figure 2 shows the dynamics of the aggregate current account balances of the North (Austria, Belgium, Finland, France, Germany, Luxemburg, and The Netherlands) and those of the South (Greece, Ireland, Italy, Portugal, and Spain).[1] The loss of competitiveness of the South and the attendant emergence of within-union external imbalances are widely regarded as important factors contributing to the euro area crisis.

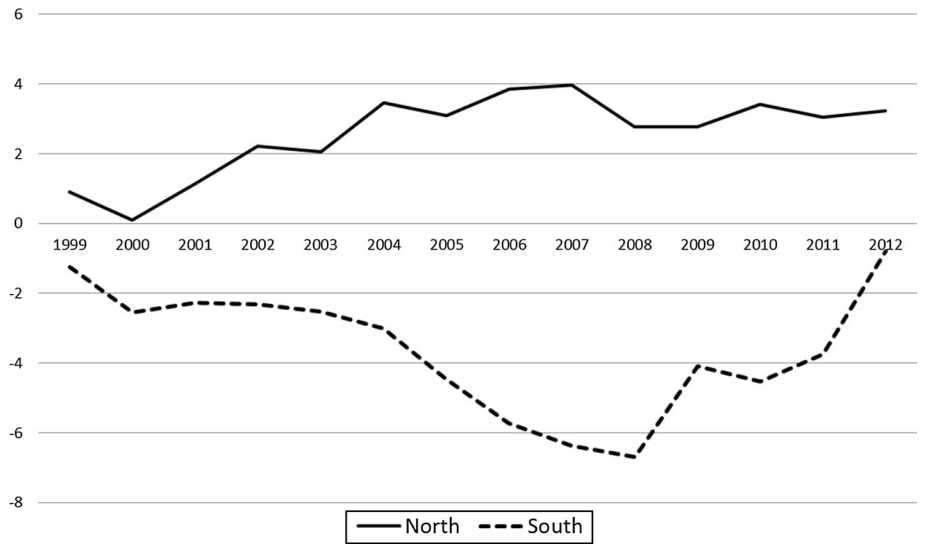
Correcting within-union imbalances is a prerequisite for overcoming the euro area crisis and putting the euro area economy back on a sustainable path. Given that exchange rate devaluations are no longer available to individual countries in the euro area, one potential way to address such imbalances is by using fiscal policy, which can, under certain circumstances, replicate the impact of exchange rate devaluations.

The idea of "fiscal devaluations" is not a new one, and goes back to Keynes (1931), who stated:

> Precisely the same effects as those produced by a devaluation of sterling by a given percentage could be brought about by a tariff of the same percentage on all imports together with an equal subsidy on all exports, except that this measure would leave sterling international obligations unchanged in terms of gold.

[1]Since we have included Ireland in this group, a more precise denomination would be "Ireland and Southern European countries" but in what follows we will use "the South" for simplicity.

Figure 2. Current Account Surplus (% of GDP) of the North and the South



Source: World Bank (2013).

In its modern incarnation, Keynes' idea can be implemented not by using tariffs and subsidies—which would be inconsistent with free trade agreements in economic and monetary unions—but rather by a policy mix entailing a reduction in employers' social contributions and an increase in the value added tax (VAT).[2] Since the latter is reimbursed to exporters and levied on importers, the overall effect of such fiscal reform is to make domestic producers more competitive.

In this paper, we develop a two-country New Keynesian model, where the two countries are calibrated to represent the North and the South of the euro area. We use our model to analyze the international transmission of a revenue-neutral fiscal devaluation implemented in the South, which we model as a shift from employers' social contributions toward the VAT. The motivation for our chosen approach is that the size of the South of the euro area is large enough to affect the North. More importantly, the goal of a fiscal devaluation in the South is to correct its loss of competitiveness relative to the North and the current account imbalance within the euro area. Our approach highlights international transmission channels and allows us to analyze not only the effects of fiscal devaluations in the South on its own economies, but also the impact on economic variables in the North.

[2]CPB (2013, Section 2) surveys the literature on fiscal devaluations.

Although several existing papers have looked at fiscal devaluations, most of them use small open economy frameworks, and as such, they cannot analyze the international spillover effects of fiscal devaluations. Unlike these papers, our two-country framework is well equipped to address such issues. As we explain below, our paper also differentiates itself from the only three contributions to this literature that we know of, which use a two-country framework (Farhi and others 2014; Franco, 2010; Lipinska and von Thadden, 2012). In particular, our paper's main contribution is to *quantitatively* address the *international* transmission of a "pure" fiscal devaluation and the role of sticky wages in the transmission of fiscal devaluations. The term "pure fiscal devaluation" here refers to a fiscal reform in which the increase in the VAT is compensated by a reduction in social contributions paid by employers, not by a reduction in the labor income tax.[3]

We use a model of a monetary union with imperfect competition in the goods and labor markets. As mentioned, we calibrate the two countries of the model to represent the South and the North of the euro area. In particular, the relative sizes of the two countries in the model are set to match the relative GDPs of the South and the North. We model a fiscal devaluation as a revenue-neutral shift from employers' social contributions to the VAT. The sizes of tax shocks in the South are set in such a way that VAT revenues are increased permanently by 1 percent of GDP, while SCR revenues are reduced permanently by 1 percent of GDP.

A reduction in the social contribution rate (SCR) in the South implies lower producer prices, resulting in a reduction of relative prices of the South's goods compared with the North's goods. This causes a shift in demand away from the North's goods and toward the South's goods, which results in an increase in output in the South. Due to the Calvo-pricing mechanism, after the initial reaction, a larger fraction of firms in the South become able to lower its prices. This implies an even stronger expenditure-switching effect after a few quarters. However, the positive effect from lower social contributions on the South's output is mitigated by the impact of the VAT increase on the South's prices and the ensuing price-wage dynamics. Immediately after a fiscal devaluation, wages start to adjust upward in the South. Given imperfect competition in the labor market in our model, a higher price level, caused by the increase in the VAT rate, implies that labor unions require higher nominal wages. Real marginal costs therefore start to adjust toward the original, pre-reform level and the positive effect on output gradually peters out. However, this effect is mitigated to the extent that the wage adjustment process occurs in a staggered fashion. We show that an empirically plausible degree of wage staggering a la Calvo ensures a fall in prices and a temporarily sizable increase in output. Even in the long term,

[3]Farhi and others (2014) use a two-country model to show that a fiscal devaluation can replicate the effects of a nominal exchange rate devaluation, but they numerically evaluate the effects of a fiscal devaluation on a small open economy (Spain). In addition, they do not analyze the role of sticky wages in the transmission of fiscal shocks. Lipinska and von Thadden (2012) model fiscal devaluation as a reduction in labor income taxes, rather than in SCR (see more detailed discussion below). As such, this is not a "pure" fiscal devaluation. Franco (2010) develops a two-country model of a monetary union, but calibrates it to Portugal, virtually ignoring the international transmission of fiscal devaluations.

however, the positive effect of the reduction in SCR social contributions on output still dominates the negative effect of the increase in the VAT, and a revenue-neutral fiscal devaluation still has a small positive effect on the South's output in the long term.

As a result of the effects described above, the South's output displays a hump-shaped response. Under the benchmark parameterization, a permanent fiscal devaluation increases the level of output in the South by 1.2 percent in the fourth quarter. Our sensitivity analysis confirms the main result, and shows that the peak effect on the South's level of output is—assuming sticky wages—in the 0.8–1.6 percent range, depending on the parameterization.

We also show that a fiscal devaluation has quite limited impact on the trade balance. In the South, income goes up more in the short term than in the long term. This implies that in the short term, the South's households are temporarily richer, and therefore they save by accumulating net external assets. The South's trade balance improves by 0.3 percent of GDP in the short term.

Our results are in line with those of the small open economy models used by the Bank of Portugal (2011) and the European Central Bank (2012), which find that a fiscal devaluation, of 1 percent of GDP, depreciates the real exchange rate (0.3 percent), increases the level of output (0.2–0.6 percent), and improves the current account balance (0.1–0.6 percent of GDP). We find a stronger effect on output in the short term, while the effects on the trade balance and the real exchange rate are within range of earlier results.

Lipinska and von Thadden (2012) is the paper most directly related to ours. They use a New Keynesian two-country model of a monetary union with different degrees of financial integration. Our paper differs from theirs in three dimensions. First, they model a fiscal devaluation as a permanent increase in the VAT and a reduction in the labor income tax rate, rather than as a reduction in the SCR, as we do. Second, they do not calibrate their model for a specific country or a group of countries, whereas we calibrate the two countries to the relative sizes of the South and the North of the euro area. Finally, unlike them, we analyze the impact of fiscal devaluations not only on output, but also on the trade balance.

Lipinska and von Thadden (2012) find that, in a region whose size is half of a monetary union, fiscal devaluations tend to be ineffective: they find that the peak effect on domestic output is only 0.05–0.15 percent, compared to 0.9–1.5 percent in our model. The difference between our results and theirs is due to the fact that, as mentioned above, their fiscal devaluation is modeled as a permanent increase in the VAT compensated by a reduction in the labor income tax rate. As such, this is not a "pure" fiscal devaluation because, unlike a reduction in the SCR, a reduction in the labor income tax does not necessarily imply competitiveness gains for domestic goods. One of our key findings is therefore that a fiscal devaluation in a large country, if properly modeled as a reduction in SCRs, and assuming a realistic degree of wage stickiness, can substantially increase output.

Regarding international transmission effects, we find that a fiscal devaluation in the South decreases output in the North in the short term. As mentioned earlier, a fiscal devaluation in the South causes a shift in demand away from the

North's goods, which results in a decrease in its output. However, the peak effect (the most negative effect) is only −0.1 percent.

De Mooij and Keen (2013) use a Vector Autoregression (VAR) methodology to analyze the effects of changes of the VAT and the SCR on net exports. Their results suggest that, within the euro area, a fiscal devaluation might increase the trade balance quite sizably in the short term. Their empirical results imply that raising the VAT rate by 1 percentage points and reducing the SCR rate by 1.7—the same policy that we calibrate in our model to achieve a 1 percent of GDP redistribution in taxation in the South—improves net exports by 0.4 percent of GDP. The results of our calibration are broadly consistent with these empirical estimates regarding the effect on the trade balance. In our model, under the benchmark parameterization, the trade balance of the South improves by 0.3 percent of GDP, a slightly weaker impact than the one found by de Mooij and Keen (2013).

Overall, we find that a fiscal devaluation in the South depreciates its real exchange rate, increases its output, and improves its trade balance. However, the advantageous effects of a fiscal devaluation should not be overplayed. A fiscal devaluation of 1 percent of GDP carried out by the South depreciates the real exchange rate by 0.3 percent and improves the trade balance by 0.3 percent of GDP, which are quite small effects. Figure 2 shows that the current account deficit in the South was roughly 1 percent of GDP in 2012. We show that a fiscal devaluation of roughly 4 percent of GDP is needed to correct—temporarily—the 1 percent trade balance deficit in the South. This would imply that the VAT rate needs to be increased by 4 percentage points and it may be difficult to raise VAT rates by such a large amount swiftly. In addition, a fiscal devaluation of 4 percent of GDP depreciates the real exchange rate of the South only by 1.2 percent. Our findings suggest that a fiscal devaluation alone would not be sufficient to correct the divergence in competitiveness and the current account imbalance between the South and the North of the euro area. Although a fiscal devaluation can be a useful reform to make progress in this direction, in order to be successful, it would need to be part of a wider package of policy reforms aimed at increasing the competitiveness of the South, including for example product and labor market reforms and wage moderation.

The rest of the paper is organized as follows: Section 2 presents the model. Section 3 discusses the parameterization. Section 4 analyzes the international transmission effects of the South's fiscal devaluation. Section 5 concludes the paper.

The Model

In this section, we develop a New Keynesian open economy model. The model consists of two regions that have formed a monetary union, infinitely lived households, imperfect competition and nominal rigidities in goods and labor markets, a central bank, and a fiscal authority. The two regions represent the South and the North of the euro area. We assume a continuum of households and normalize the size of the euro area to one. Households are indexed by $i \in [0, 1]$ and the relative size of the South (the North) is $1 - n$ (n).

Households

Preferences

In the baseline model, all households are identical and we present only the equations for the South if the equations are symmetric across regions. Households in the South maximize their intertemporal utility function

$$U_t^R = \mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \left\{ \log C_{t+k} - \frac{(N_{t+k})^{1+\emptyset}}{1+\emptyset} \right\}, \tag{1}$$

where $\mathbb{E}_t$ is the expectation operator, β is the discount factor, C_t is a consumption index, N_t is the households' labor supply, and $1/\emptyset$ is the Frisch elasticity of labor supply.

The consumption index is[4]

$$C_t = \left\{ (1-\omega)^{\frac{1}{\sigma}} \left(C_t^S\right)^{\frac{\sigma-1}{\sigma}} + \omega^{\frac{1}{\sigma}} \left(C_t^N\right)^{\frac{\sigma-1}{\sigma}} \right\}^{\frac{\sigma}{1-\sigma}}, \tag{2}$$

where C_t^S and C_t^N , respectively, denote the consumption by households in the South of the South's and the North's goods, σ is the elasticity of substitution between the South's and the North's goods (cross-country substitutability, for short), and ω is the steady-state share of imported goods in the consumption basket of the South.

The consumption of the South's and the North's goods $C_t^S$and C_t^N are defined as

$$C_t^S = \left[(1-n)^{-\frac{1}{\epsilon}} \int_n^1 \left(c_t^S(i)\right)^{\frac{\epsilon-1}{\epsilon}} di \right]^{\frac{\epsilon}{\epsilon-1}}, \quad C_t^N = \left[n^{-\frac{1}{\epsilon}} \int_0^n \left(c_t^N(i)\right)^{\frac{\epsilon-1}{\epsilon}} \mathrm{d}i \right]^{\frac{\epsilon}{\epsilon-1}},$$

where $c_t^S(i)$ and $c_t^N(i)$, respectively, denote the consumption of the differentiated goods produced in the South and in the North by households in the South and ϵ is the elasticity of substitution between goods produced in the same region. We refer to ϵ as the within-country substitutability.

Given the consumption indexes, the South's demands for the representative good i produced in the South and in the North are

$$c_t^S(i) = \frac{1-\omega}{1-n} \left(\frac{p_t^S(i)}{P_t^S} \right)^{-\epsilon} \left(\frac{P_t^S}{P_t} \right)^{-\sigma} C_t,$$

[4]The household in the North has the following consumption index (the North's variables are denoted by an asterisk):

$$C_t^* = \left\{ (1-\omega^*)^{\frac{1}{\sigma}} \left(C_t^{*N}\right)^{\frac{\sigma-1}{\sigma}} + (\omega^*)^{\frac{1}{\sigma}} \left(C_t^{*S}\right)^{\frac{\sigma-1}{\sigma}} \right\}^{\frac{\sigma}{1-\sigma}},$$

where ω^* is the share of imported goods.

$$c_t^N(i) = \frac{\omega}{n}\left(\frac{P_t^N(i)}{P_t^N}\right)^{-\epsilon}\left(\frac{P_t^N}{P_t}\right)^{-\sigma} C_t,$$

respectively, where $P_t^S(i)$ is the price of the South's good i, $P_t^N(i)$ is the price of the North's good i, and $P_t^S(P_t^N)$ is the price index corresponding to the South's (North's) consumption basket $C_t^S(C_t^N)$ and P_t is the South's consumer price index. They are defined as follows:

$$P_t^S = \left((1-n)^{-1}\int_n^1 p_t^S(i)^{1-\epsilon}\mathrm{d}i\right)^{\frac{1}{1-\epsilon}},$$

$$P_t^N = \left(n^{-1}\int_0^n p_t^N(i)^{1-\epsilon}\mathrm{d}i\right)^{\frac{1}{1-\epsilon}},$$

$$P_t = \left((1-\omega)\left(P_t^S\right)^{1-\sigma} + \omega\left(P_t^N\right)^{1-\sigma}\right)^{\frac{1}{1-\sigma}}.$$

The corresponding price indexes for the North are defined analogously. For future reference, we define the South's terms of trade, denoted by S_t, as the relative price of the North's goods in terms of the South's goods

$$S_t = \frac{P_t^S}{P_t^N}.$$

In addition, the consumer price-index-based real exchange rate, denoted by *RER*, is defined as

$$RER_t = \frac{P_t}{P_t^*},$$

where P_t^* is the North's consumer price index.

Budget Constraints and Consumption Decisions

The budget constraint of the South's household is given by

$$B_{t+1} + \left(1+\tau_t^{\mathrm{VAT}}\right)P_t C_t = R_{t-1}B_t + W_t N_t + \Pi_t + T_t. \tag{3}$$

B_t denotes the holding of nominal bonds at the beginning of period t, τ_t^{VAT} is the VAT rate, R_{t-1} is the gross return on bonds between $t-1$ and t, W_t is the economy-wide nominal wage paid to the household, Π_t denotes nominal profits of the South's firms, and T_t denotes transfers from the government.

The optimal consumption paths are governed by the following Euler equations:

$$R_t^{-1} = \beta \mathbb{E}_t \left\{ \frac{C_t}{C_{t+1}} \frac{P_t}{P_{t+1}} \frac{1+\tau_t^{\text{VAT}}}{1+\tau_{t+1}^{\text{VAT}}} \right\}, \tag{4}$$

$$\left(R_t^*\right)^{-1} = \beta \mathbb{E}_t \left\{ \frac{C_t^*}{C_{t+1}^*} \frac{P_t^*}{P_{t+1}^*} \frac{1+\tau_t^{*\text{VAT}}}{1+\tau_{t+1}^{*\text{VAT}}} \right\}.$$

A simple way to render the model stationary is to assume that the domestic interest rate is increasing in the level of net foreign debt (Schmitt-Grohé and Uribe, 2003). We include a risk premium for the interest rate parity condition that forces external debt in the long term to return to the initial level. The interest parity condition with risk premium is given by

$$R_t = R_t^* - \psi(\exp(B_t) - 1),$$

where $\psi(\exp(B_t) - 1)$ is the risk premium.

Aggregate Demand and the Trade Balance

Total demand for the South's good i is the sum of the demand in South and in the North, as follows:

$$Y_t(i) = \left(\frac{p_t^S(i)}{P_t^S} \right)^{-\epsilon} \left[(1-\omega) \left(\frac{P_t^S}{P_t} \right)^{-\sigma} C_t + \frac{n}{1-n} \omega^* \left(\frac{P_t^S}{P_t^*} \right)^{-\sigma} C_t^* \right].$$

Defining $Y_t^S \equiv (1-\omega) \left(\frac{P_t^S}{P_t} \right)^{-\sigma} C_t + \frac{n}{1-n} \omega^* \left(\frac{P_t^S}{P_t^*} \right)^{-\sigma} C_t^*$ as total consumption of the bundle containing South's goods, we get the aggregate demand for good i:

$$Y_t(i) = \left(\frac{p_t^S(i)}{P_t^S} \right)^{-\epsilon} Y_t^S \tag{5}$$

One idea of a fiscal devaluation is to improve the trade balance. For future reference, we define the real trade balance (TB), expressed in terms of the domestic goods bundle, as follows:

$$\frac{TB_t}{P_t^S} = Y_t - \frac{P_t}{P_t^S} C_t.$$

Wage Setting and Employment

Typical features of European labor markets are a strong influence of labor unions and sticky wages. We therefore assume imperfect competition in the labor market and sticky wages. Workers supply a differentiated and imperfectly substitutable input to firms. Workers delegate wage setting to type-specific labor unions that exploit the market power in wage setting.

We introduce wage rigidities in the form of staggered nominal wage setting à la Calvo (1983). A labor union representing type z workers may reset its wages in any given period with a probability $1 - \theta_w$, independently of the amount of time since the last wage adjustment. Therefore, labor union z's objective is given by

$$\max_{W_t(z)} \sum_{k=0}^{\infty} \beta^k \theta_w^k \mathbb{E}_t \left\{ \frac{1}{C_{t+k}} \frac{W_t(z)}{\left(1+\tau_t^{\mathrm{VAT}}\right) P_{t+k}} N_{t+k|t}(z) - \frac{N_{t+k|t}^{1+\emptyset}(z)}{1+\emptyset} \right\}, \tag{6}$$

where $N_{t+k|t}(z)$ is the employment level of z type workers in period $t + k$ and whose union is able to reset the type-specific wage rate $W_t(z)$ in period t. In setting wages, the labor union takes into account the firms' labor demand. Firm i employs $N_t(i, z)$ hours of all labor types z and aggregates them to the labor index $N_t(i)$ given by

$$N_t(i) = \left[(1-n)^{-\frac{1}{\epsilon_w}} \int_n^1 N_t(i,z)^{\frac{\epsilon_w - 1}{\epsilon_w}} \mathrm{d}z \right]^{\frac{\epsilon_w}{\epsilon_w - 1}}, \tag{7}$$

where ϵ_w is the elasticity of substitution between different types of labor. Equation (7) is used to derive firm i's demand for labor-type z, to give

$$N_t(i,z) = \frac{1}{1-n} \left(\frac{W_t(z)}{W_t} \right)^{-\epsilon_w} N_t(i), \tag{8}$$

where W_t is the average wage level in the South, which is

$$W_t = \left[\frac{1}{1-n} \int_n^1 (W_t(z))^{1-\epsilon_w} \mathrm{d}z \right]^{\frac{1}{1-\epsilon_w}}. \tag{9}$$

Aggregation of the firm-specific demand functions over all firms yields the aggregate demand for labor-type z, as follows:

$$\int_n^1 N_t(i,z) di \equiv N_t(z) = \left(\frac{W_t(z)}{W_t} \right)^{-\epsilon_w} \frac{1}{1-n} \int_n^1 N_t(i) \mathrm{d}i. \tag{10}$$

The labor union maximizes Eq. (6) while taking into account Eq. (10). The first-order condition is

$$\sum_{k=0}^{\infty} \beta^k \theta_w^k \mathbb{E}_t \left\{ N_{t+k|t}(z) \left(\frac{1}{C_{t+k}} \frac{W_t^O}{\left(1+\tau_t^{\mathrm{VAT}}\right) P_{t+k}} - \frac{\epsilon_w}{\epsilon_w - 1} \left(N_{t+k|t}(z) \right)^{\emptyset} \right) \right\} = 0, \tag{11}$$

where W_t^O is the optimal wage set by unions that reset their wages in period t. In the optimum, the weighted average of the marginal utility of the real wage, which is implied by setting $W_t(z)$ today, equals the average marginal disutility from working an extra hour.

The structure of wage setting implies that in each period a fraction of labor unions, $1-\theta_w$, set a new wage, and the remaining fraction keep their wages unchanged. This implies that the aggregate wage index is

$$W_t = \left[\theta_w (W_{t-1})^{1-\epsilon_w} + (1-\theta_w)(W_t^O)^{1-\epsilon_w}\right]^{\frac{1}{1-\epsilon_w}}. \tag{12}$$

Aggregate employment N_t is the sum over all firms i and types of labor z, as follows:

$$N_t \equiv \frac{1}{1-n}\int_n^1 \int_n^1 N_t(i,z)\mathrm{d}i\mathrm{d}z. \tag{13}$$

Employing the definitions of price dispersion $s_t^p \equiv \frac{1}{1-n}\int_n^1 \left(\frac{P_t(i)}{P_t^S}\right)^{-\epsilon}\mathrm{d}i \geq 1$ and wage dispersion $s_t^w \equiv \frac{1}{1-n}\int_n^1 \left(\frac{W_t(z)}{W_t}\right)^{-\epsilon_w}\mathrm{d}z \geq 1$, as well as total demand for good i (Eq. (5)) and the linear production function introduced below (Eq. (15)), it can easily be shown that aggregate employment is governed by

$$N_t = s_t^p s_t^w Y_t. \tag{14}$$

We see that in the presence of wage or price dispersion, one unit of consumption of the domestic bundle requires more than one unit of aggregate employment, due to inefficiencies caused by price and wage rigidities.

Firms and Price Setting

The production function of the typical firm i is

$$Y_t(i) = N_t(i), \tag{15}$$

where $Y_t(i)$ is firm i's output and $N_t(i)$ is firm i's effective employment (net of inefficiencies due to wage dispersion), specified in Eq. (7).

We assume that the payroll tax is paid by firms, and we refer to it as social contributions. Firm i's profits are given by

$$\Pi_t(i) = P_t^S(i)Y_t(i) - \left(1+\tau_t^{\mathrm{SCR}}\right)\int_n^1 W_t(z)N_t(i,z)\mathrm{d}z,$$

where τ_t^{SCR} is the social contribution rate (SCR). Employing firm i's demand for labor-type z (Eq. 8) and a wage dispersion index $sw_t \equiv \frac{1}{1-n}\int_n^1 \left(\frac{W_t(z)}{W_t}\right)^{1-\epsilon_w}\mathrm{d}z$, we can express profits as follows:

$$\Pi_t(i) = P_t^S(i)Y_t(i) - \left(1+\tau_t^{\mathrm{SCR}}\right)sw_t W_t N_t(i)$$

Wage dispersion ($sw_t > 1$) implies an inefficient allocation in the employment of different types of labor, which increases the total amount of labor required to produce a given amount of output. A higher wage bill lowers profits for a given amount of output.

We introduce price rigidities in the form of staggered price setting à la Calvo (1983). Each firm may reset its price with a probability $1 - \theta_p$, independent of the time elapsed, since the last adjustment and independent of other firms. With Calvo pricing, firm i seeks to maximize the discounted value of expected profits

$$\max_{P_t(i)} \mathbb{E}_t \sum_{k=0}^{\infty} \theta_p^k Q_{t,t+k} \Pi_{t+k}(i),$$

where $Q_{t,t+k} \equiv \beta^k \mathbb{E}_t \left\{ \frac{C_t}{C_{t+k}} \frac{P_t}{P_{t+k}} \frac{1+\tau_t^{\text{VAT}}}{1+\tau_{t+k}^{\text{VAT}}} \right\}$ is a stochastic discount factor between period t and period $t + k$. The first-order condition for the firm's maximization problem is

$$\mathbb{E}_t \sum_{k=0}^{\infty} \theta_p^k Q_{t,t+k} \mathrm{Y}_{t,t+k} \left[P_t^O - \frac{\epsilon}{\epsilon - 1} MC_{t+k} \right] = 0, \tag{16}$$

where P_t^O is the optimal price in period t, $\mathrm{Y}_{t,t+k}$ is the level of period $t + k$ output produced by the firms that reset their price in period t, and MC_t is the marginal cost, defined as

$$MC_t = \left(1 + \tau_t^{\text{SCR}}\right) W_t \frac{1}{1-n} \int_n^1 \left(\frac{W_t(z)}{W_t} \right)^{1-\epsilon_w} dz.$$

Alternatively, using the definition of wage dispersion, the marginal cost can be expressed as follows:

$$MC_t = \left(1 + \tau_t^{\text{SCR}}\right) s_t^w W_t. \tag{17}$$

The presence of wage dispersion ($s_t^w > 1$) implies an inefficient usage of labor types. This increases the amount of labor required to produce an additional unit of output and thereby marginal costs.

Aggregate Prices and Aggregate Supply

With Calvo pricing, the price index of the South's goods is

$$P_t^S = \left[\theta_p (1-n)^{-1} \int_n^1 (P_{t-1}(i))^{1-\epsilon} \mathrm{d}i + (1-\theta_p)(P_t^O)^{1-\epsilon} \right]^{\frac{1}{1-\epsilon}}. \tag{18}$$

In Eq. (18), the integral contains only the prices of the South's goods whose prices are not allowed to be reset in period t. From the law of large numbers, for

those firms, the average price P^S_{t-1} prevails and their mass equals θ_p, so that the price index becomes

$$P^S_t = \left[\theta_p \left(P^S_{t-1}\right)^{1-\epsilon} + (1-\theta_p)(P^O_t)^{1-\epsilon}\right]^{\frac{1}{1-\epsilon}}. \tag{19}$$

Equations (8), (10)–(14), (16), (17) and (19) determine aggregate supply.

Fiscal and Monetary Policy

We assume that all government spending is for public transfers to households, which can be financed through the VAT and social contributions. We therefore abstract from government consumption. The budget constraint of the government is given by

$$\tau^{\text{VAT}}_t P_t C_t + \tau^{\text{SCR}}_t W_t N_t = T_t.$$

The first part of the left side of the above equation is tax revenue from value added taxation and the second part is social contribution tax revenue.

We assume that the VAT and SCR tax rates follow AR(1) processes

$$\tau^{\text{VAT}}_t = \rho^{\text{VAT}} \tau^{\text{VAT}}_{t-1} + \varepsilon^{\text{VAT}}_t,$$

$$\tau^{\text{SCR}}_t = \rho^{\text{SCR}} \tau^{\text{SCR}}_{t-1} + \varepsilon^{\text{SCR}}_t,$$

where ρ^{VAT} and $\rho^{\text{SCR}} \in [0,1]$ and $\varepsilon^{\text{VAT}}_t$ and $\varepsilon^{\text{SCR}}_t$ are zero mean white-noise processes that represent unexpected changes to tax rates.

We assume that the central bank of the euro area follows a Taylor-type interest rate rule with interest rate smoothing. The central bank responds to euro area inflation, which is the population-weighted average of domestic inflation. Lipinska and von Thadden (2012) show that the short-term effects of a shift in taxation depend on whether the monetary policy rule is specified in terms of pre-tax or after-tax consumer price inflation. We believe that it is reasonable to assume—in the current economic situation—that the central bank would not react to the South's one-off inflation caused by an increase in the VAT rate. The interest rate without interest rate smoothing, denoted by R^{WS}_t, is determined by the following monetary policy rule:

$$R^{WS}_t = \beta^{-1} \left(\left(\frac{P^S_t}{P^S_{t-1}} \right)^{1-n} \left(\frac{P^N_t}{P^N_{t-1}} \right)^{n} \right)^{\alpha_\pi},$$

where the coefficient α_π is non-negative and chosen by the central bank. The actual interest rate of the euro area, denoted by R_t, is

$$R_t = \left(R^{WS}_t\right)^{1-\rho^R} \left(R_{t-1}\right)^{\rho^R},$$

where $\rho^R \in (0,1)$ captures the degree of interest rate smoothing.

Parameter Values

The parameterization of the model, summarized in Table 1, is chosen to match the features of the South and the North of the euro area. The model, however, is solved around the steady state where initial net foreign assets are zero. Periods are interpreted as quarters and the discount factor is set to 0.99. The relative size of the South, $1 - n$, is set to match the relative GDPs of the regions. According to the World Bank (2013), the relative size of the South's output in 2011 was 0.34. We therefore set $1 - n = 0.34$. The labor supply parameter, $\emptyset$, is set to one. This implies that the Frisch elasticity of labor supply is one, a value consistent with Kimball and Shapiro (2008).

The coefficient (α_π) in the monetary policy rule is set to 1.5, based on Taylor (1993). As emphasized by Lipinska and von Thadden (2012), empirical DSGE models of the euro area show a high degree of interest rate smoothing. The degree of interest rate smoothing (ρ^R) is set to 0.95, as in Lipinska and von Thadden (2012). The risk premium in the interest rate parity (ψ) is set to 0.000001. A non-zero risk premium forces the net level of foreign debt to eventually revert to its initial level, thereby inducing stationarity of the model. This reversion occurs a very long time after the implementation of a fiscal devaluation due to the very low value of the risk premium. As a result, the reversion has negligible implications for the short-term adjustment to a fiscal devaluation, which makes this assumption uncritical for the exercise at hand.

We set the elasticity of substitution between goods produced in the same region ϵ to 9, implying a steady-state price markup of 12.5 percent. Our chosen value is in the middle of the 6 to 11 range typically used in the literature. In addition, this value is often used in the New Keynesian literature, such as by Galí (2011), for example.

Table 1. Parameterization of the Model

Parameter	Value	Description
β	0.99	Discount factor
$1 - n$	0.34	Relative size of the South
$\emptyset$	1	Labor supply parameter
ϵ	9	Elasticity of substitution between goods within regions
σ	2	Cross-country substitutability
ω	0.33	Share of imported goods in the South's consumption basket
ω^*	0.17	Share of imported goods in the North's consumption basket
τ^{VAT}, τ^{*VAT}	0.16	VAT rate
τ^{SCR}, τ^{*SCR}	0.24	SCR rate
α_π	1.5	Coefficient in the monetary policy rule
ρ^R	0.95	Interest rate smoothing
ψ	0.000001	Risk premium
ϵ_w	9	Elasticity of substitution between different types of labor
θ_p	0.66	Degree of price stickiness
θ_w	0.75	Degree of wage stickiness
ρ^{VAT}, ρ^{SCR}	0.999999	Persistence of tax shocks

In the business cycle literature, a wide range of values for the elasticity of substitution between different types of labor (ϵ_w) has been used. For example, Adolfson and others (2007) use the value 21 in a model calibrated for the euro area, Kormilitsina and Nekipelov (2012) use 6 and Coenen and others (2010) use 3. We set the parameter to 9, which is near the middle of the range used in the literature. This parameterization implies that the elasticity of substitution between different types of labor is equal to the elasticity of substitution between goods produced in the same region.

Cross-country substitutability, the elasticity of substitution between the South's and the North's goods (σ), is a key parameter, because it affects the strength of the expenditure-switching effect. The empirical literature shows a wide range of estimates for it. Feenstra and others (2012) find that the microelasticity (substitution between different import suppliers) between domestic and foreign goods is 3, whereas the macroelasticity (substitution between domestic production and imports) does not significantly differ from unity. We set cross-country substitutability to 2, which is an average of these estimates.

The share of imported goods in the South's consumption basket,ω, is set to match these countries' GDP-weighted import-to-GDP ratios. Our calculation, using the World Bank data (World Bank, 2013), shows that the ratio is 33 percent, so ω is set to 0.33. We assume that the per-capita levels of output and consumption are identical across regions. This requires that $\omega^* = \omega(1 - n/n)$ so that the implied share of imported goods in the North consumption basket (ω^*) is 17 percent.

Kemmerling (2009) calculates effective social contribution and VAT tax rates for euro area countries (excluding Luxembourg). Our calculation shows that the GDP-weighted average for the VAT (SCR) rate in the euro area (excluding Luxembourg) is 16 percent (24 percent). We, therefore, set the VAT rate to 16 percent and the SCR rate to 24 percent. In comparison, Lipinska and von Thadden (2012) set the VAT rate to 15 percent, based on the nominal consumption tax rates in the euro area.

Wage and price rigidities are key variables in determining the adjustment of the two economies to a fiscal devaluation. Druant and others (2009) analyze wage and price adjustment in ten euro area countries and find that the average duration of wages (excluding Italy) is roughly one year. We match this figure by setting the Calvo parameter for wages (θ_w) to 0.75.

Druant and others (2009) find that prices are adjusted more frequently than wages. In ten euro area countries, the average duration of prices is 9.6 months. We set the Calvo parameter for prices (θ_p) to 0.66, which implies an average duration between price adjustments of 9 months.

Parameters ($\rho^{\mathrm{VAT}}, \rho^{\mathrm{SCR}}$) that govern the persistence of the South's tax shocks are set to 0.999999 (the North keeps their tax rates unchanged). This implies that tax shocks are virtually permanent.[5] We consider a revenue-neutral shift from social contributions toward the VAT. The sizes of one-off tax shocks ($\varepsilon_t^{\mathrm{VAT}}, \varepsilon_t^{\mathrm{SCR}}$)

[5]To check the validity of this approach, we compared the convergent impulse responses with the steady state that would result from the new tax rates.

in the South are set such that the VAT revenue is increased by 1 percent of ex-post GDP, while social contribution revenue is reduced by 1 percent of ex-post GDP.

International Effects of a Fiscal Devaluation in the South

In this section, we analyze the international transmission of a fiscal devaluation in the South. We model a fiscal devaluation as a shift from social contributions to VAT equivalent of 1 percent of ex-post GDP. Our parameterization implies that, in order to achieve a shift of this magnitude, the VAT rate needs to be increased by 1 percentage point, whereas the SCR needs to be reduced by 1.7 percentage points. We solve the model by using a perturbation method based on a second-order accurate approximation of the system of equations. After showing the effects of a fiscal devaluation, we go into more detail to shed light on the precise mechanisms at play (Section 4.1) and then do sensitivity analyses (Section 4.2).

The response of the main macroeconomic variables to a fiscal devaluation is shown in Figure 3. In all figures, the horizontal axis denotes time. The vertical axis typically shows percentage deviations from the initial steady state. However, the change in bond holdings, whose initial steady state is zero, is expressed as a deviation from initial GDP. In addition, the responses of inflation and interest rates are expressed as basis point deviations in annual terms.

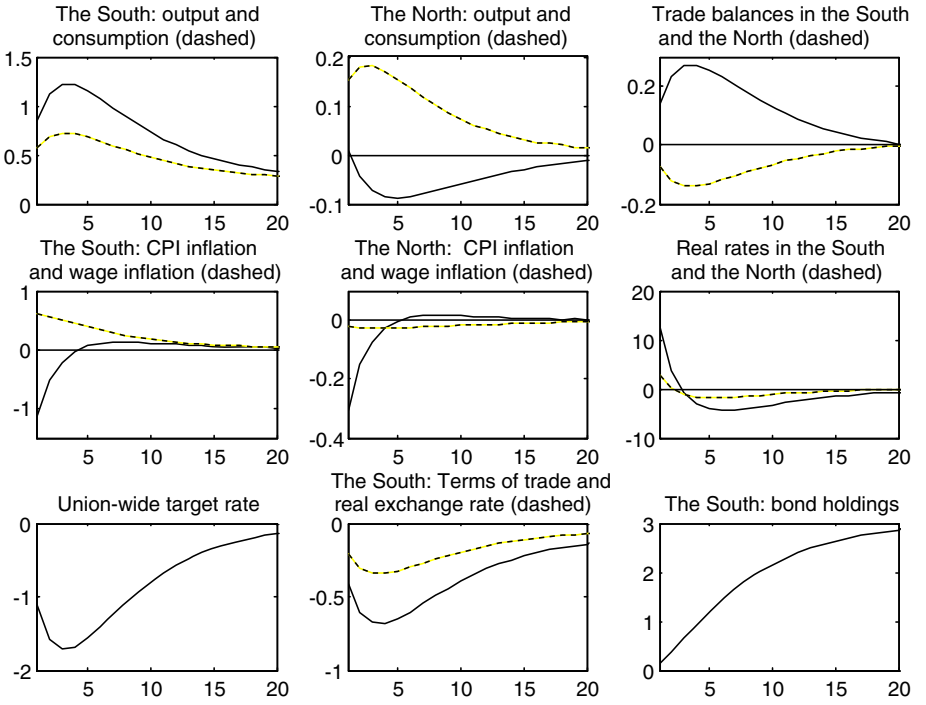
Inflation and interest rates are expressed in annualized percentage points and basis point deviations, respectively. Deviations of trade balances are expressed in percentage of the initial GDP. For all other variables, we report percentage deviations from their steady-state values.

Figure 3 emphasizes that a reduction in the SCR in the South implies a fiscal devaluation, which on impact lowers the relative price of the South's goods (a terms of trade deterioration for the South). The channel through which this terms-of-trade deterioration comes about is that the reduction in SCR lowers marginal costs for the South's firms, thus reducing producer prices.

The other component of the fiscal reform, the increase in the VAT rate in the South, pushes consumer prices up, mitigating the reduction in producer prices. However, the VAT increases the consumer price of the North's goods as well as of those of the South, while the reduction in SCR only reduces the South's prices. This mechanism is the essence of a fiscal devaluation, and results in lower relative prices of the South's goods, which, under a fixed nominal exchange rate, is equivalent to a real exchange rate devaluation.

The large increase in the South's output in the short term is demand driven. The terms of trade deterioration and the corresponding real exchange rate depreciation for the South cause the traditional expenditure-switching effect of an exchange rate change, a shift of euro area demand away from the more expensive North's goods and toward the cheaper South's goods. This expenditure-switching effect increases the South's output (employment) and decreases the North's output (employment) in the short term.

Figure 3. Dynamic Effects of a Fiscal Devaluation



Inflation and interest rates are expressed in annualized percentage points and basis point deviations, respectively. Deviations of trade balances are expressed in percentage of the initial GDP. For all other variables we report percentage deviations from their steady state values.

Due to the Calvo-pricing mechanism at work in the model, however, only a fraction of firms can lower prices on impact following the SCR reduction. After a few quarters, however, a larger fraction of the South's firms become able to lower their prices. This implies that the expenditure-switching effect becomes even stronger after a few quarters, pushing the South's output further up. As Figure 3 shows, a fiscal devaluation increases the South's level of output by 0.8 percent in the first quarter, while the peak impact is 1.2 percent in the fourth quarter.

However, the positive effect of a fiscal devaluation on the South's output through the expenditure-switching effect is mitigated by the wage-price dynamics. Immediately after a fiscal devaluation, wages start to adjust upwards in the South. This happens because the increase in consumption prices, caused by the increase in the VAT rate, pushes labor unions to require higher nominal wages. As a consequence, real marginal costs in the South, which had fallen on impact due to the reduction in the SCR rate, start to adjust toward the original, pre-reform level. This has a negative effect on output in the South, which gradually offsets the positive impact of the expenditure-switching effect discussed above. As a consequence of the various effects, output in the South

displays a hump-shaped response to a fiscal devaluation in these countries, and the tax reform still has a small positive effect on output, even in the long term.

Looking at the international transmission effects of fiscal devaluations, Figure 3 shows that the North's output decreases immediately after the reform. This result is due to the expenditure-switching effect, as discussed earlier. The peak effect (the most negative effect) on the North's output is −0.09 percent in the fifth quarter after a fiscal devaluation. After that, as inflation in the South and the real exchange rate stabilize, the expenditure-switching effect peters out, and output in the North slowly adjusts back to its pre-shock level.

In terms of effects on the external position, Figure 3 shows that in the South, both output and consumption increase following a fiscal devaluation. However, the increase in consumption is smaller than that of output, due to the deterioration in the terms of trade of the South. As a consequence, households save a fraction of their increased income, leading to an improvement in the trade balance by about 0.27 percent of GDP, and to an accumulation of net foreign assets by the South, which at its peak amounts to slightly more than 3 percent of GDP.

However, the small risk premium in the interest rate parity equation forces bond holdings of the South to slowly revert toward their initial level in the long term. In the medium term, households in the South start using their accumulated wealth to finance consumption. As a consequence, the South's trade balance turns negative twenty quarters after a fiscal devaluation, and bond holdings of the South start declining, slowly reverting back to their pre-shock level. But note that since these are medium-term dynamics, the risk premium has no effect on the short-term adjustment and therefore does not inhibit the effects of a fiscal devaluation. Our results suggest that a fiscal devaluation could be used as a part of a policy package aimed at increasing output in the South and balancing the euro area economy. In particular, Figure 3 shows that the positive impact on the output and consumption of the South is larger than the negative impact on output and consumption of the North. In addition, the former is permanent, in the sense that even in the long term a small positive effect persists, whereas the latter is temporary, since the North's output and consumption revert back to their initial levels.

Our results therefore lend some support to the argument—made, for example, by IMF (2011)—that fiscal devaluations should not be seen primarily as a form of tax competition, but that they might entail a structural improvement. Arnold and others (2011) have stressed that the shift from labor taxes to consumption taxes can increase the level of GDP in the long term, because consumption taxes are less distortive taxes in terms of discouraging work, compared to labor taxes. From this point of view, a fiscal devaluation carried out in a monetary union entails benefits for not only the countries who implement it (by making their goods more competitive) but also for the union as a whole, by shifting the tax system in the union toward a less distortive one.

Our results however suggest that a fiscal devaluation is not an effective means for addressing the divergence in competitiveness and the current account imbalance between the North and the South. In our model, a fiscal devaluation of roughly 4 percent of GDP is needed to correct—temporarily—the 1 percent trade balance deficit in the South. A fiscal devaluation of 4 percent of GDP implies that

the VAT rate needs to be increased by 4 percentage points. VAT rates are already quite high in the South (see e.g., de Mooij and Keen, 2013) and it may be difficult to raise them by such a large amount quickly. In addition, a fiscal devaluation of this size depreciates the real exchange rate of the South only by 1.2 percent. Overall, our findings indicate that it might be misleading to suggest that significant gains in competitiveness and net trade can be expected through a fiscal devaluation.

De Mooij and Keen (2013) emphasize that there is almost no empirical evidence on trade impacts of tax reforms or fiscal devaluations. Franco (2011) analyzes the effects of changes of value added taxes and social contribution rates on real exports and imports in Portugal using a VAR methodology. His findings support both the feasibility and the effectiveness of fiscal devaluations.[6] In particular, he finds that a positive one standard deviation VAT shock decreases real imports by 3.4 percent, while a negative one standard deviation SCR shock increases real exports by 4.4 percent.

De Mooij and Keen (2013) carry out a similar analysis using a panel of OECD countries. They find that, for euro area countries, a shift of 1 percent of GDP from social contributions to the VAT would increase net exports by about 0.9–4 percent of GDP, depending on the specification of the model. The estimate is smaller and statistically insignificant for countries outside the euro area. Their result, however, suggests that, within the euro area, whereas a fiscal devaluation might increase the trade balance quite sizably in the short term, the effects eventually disappear in the medium to long term. There seems to be a wide gap between our results (and all other theoretical results) and those of de Mooij and Keen (2013). Their empirical results, however, imply that raising the VAT rate by 1 percentage point and reducing the SCR by 1.7—the same policy that we calibrate in our model to achieve a 1 percent of GDP redistribution in taxation in the South—improves net exports by 0.4 percent of GDP.[7] The results of our paper are broadly consistent with these empirical estimates regarding the effect on the trade balance. In our model, under the benchmark parameterization, the trade balance of the South improves by 0.27 percent of GDP, a somewhat weaker impact than the one found by de Mooij and Keen (2013). Consistent with the empirical evidence, we also find that the effect on the trade balance eventually disappears.

Farhi and others (2014) use a new Keynesian two-country DSGE model to show that, even in the case of fixed exchange rates, fiscal policy can replicate the resource allocation attained under a nominal exchange rate devaluation. In particular, they find that two kinds of fiscal policy reforms can be equivalent to an exchange rate devaluation: a uniform increase in import tariff and export subsidy, and a VAT increase and a uniform SCR reduction. However, they do not use their

[6]Ivanova (2012), on the other hand, finds that reducing taxes on labor may actually worsen the current account balance.

[7]De Mooij and Keen's (2013) estimates, using statutory tax rates, show that a 1 percentage point increase of the VAT rate (SCR) increases (reduces) net exports by 0.23 (0.11) percent. These estimates imply that raising the VAT rate by 1 percentage points and reducing the SCR by 1.7 percentage points improves net exports by $(-0.11 \times -1.7) + (0.23 \times 1) = 0.417$ percent of GDP.

two-country framework to analyze quantitatively the international transmission of a fiscal devaluation and the role of sticky prices in the transmission, as we do.[8]

Most previous papers have looked at these issues using small open economy models. A study by the Bank of Portugal (2011) looks at the impact of a balanced-budget tax policy reform aimed at increasing the external competitiveness, using a small open economy model calibrated to the Portuguese economy. The reform consists of a 1 percent of GDP reduction in social contributions offset by an increase in consumption taxes. The result shows that a fiscal devaluation brings about a permanent real exchange rate depreciation of about 0.3 percent, which results in a permanent increase in output of about 0.6 percent, with the current account increasing on impact by 0.6 percent.

The European Central Bank (2012) uses three different multi-country models—the National Institute Global Econometric Model (NiGEM), the New Multi-Country Model (NMCM), and the Euro Area and Global Economy (EAGLE) model—to analyze the effects of a fiscal devaluation in an individual country of the euro area, which can be considered a small open economy compared to the rest of the union. Their study finds that a fiscal devaluation—defined as an ex ante revenue-neutral 1 percent of GDP cut in social contributions offset by a rise in VAT over 5 years—implies a hump-shaped response in output, with almost no effect on impact but a peak effect in the range of 0.2–0.5 percent after 6–9 quarters. The effect on the current account is also negligible on impact, and the peak effect is in the 0.1–0.5 range. We find a much stronger effect on output in the short term, whereas the trade impact is in the range of the findings of the ECB.

Our result, that a fiscal devaluation is effective in terms of stimulating domestic output, is in contrast with that of Lipinska and von Thadden (2012). As mentioned in the introduction, Lipinska and von Thadden (2012) analyze fiscal devaluation using a New Keynesian two-country model of a monetary union. Their model, therefore, is most directly related to ours. They find that the effectiveness of a fiscal devaluation depends on the degree of financial integration between the two countries. They, however, find that in a region whose size is half of a monetary union, fiscal devaluations tend to be ineffective. The peak effect on domestic output is only 0.05–0.15 percent in their model, compared to 1.2 percent in our model. In addition, the spillover effect on foreign output is also very small. In the next section, we provide a detailed discussion of the differences between our results and theirs. It turns out that wage rigidity plays a crucial role in our model.

The Role of Wage Rigidity and Labor Taxation

The difference between our results and those of Lipinska and von Thadden (2012) can—to a large extent—be explained by different types of shocks. In their model, fiscal devaluation is a permanent increase in the VAT by 1 percentage point and the additional VAT revenues are used to reduce the *labor* income tax

[8]Farhi and others (2014) numerically evaluate the effects of a fiscal devaluation on a small open economy, calibrated to match the features of Spain.

such that the home country's long-term level of real government debt stays unchanged.[9] In order to compare this version of a fiscal devaluation with the version that reduces the SCR, we replicate their version of a fiscal devaluation in our model. To this aim, we introduce labor income taxes, so the budget constraint of the representative household is now

$$B_{t+1} + \left(1 + \tau_t^{\mathrm{VAT}}\right) P_t C_t = R_{t-1} B_t + \left(1 - \tau_t^{w}\right) W_t N_t + \Pi_t + T_t,$$

where τ_t^w is the labor income tax. The comparison is conducted separately in a model with flexible wages and with sticky wages.

Model with Flexible Wages

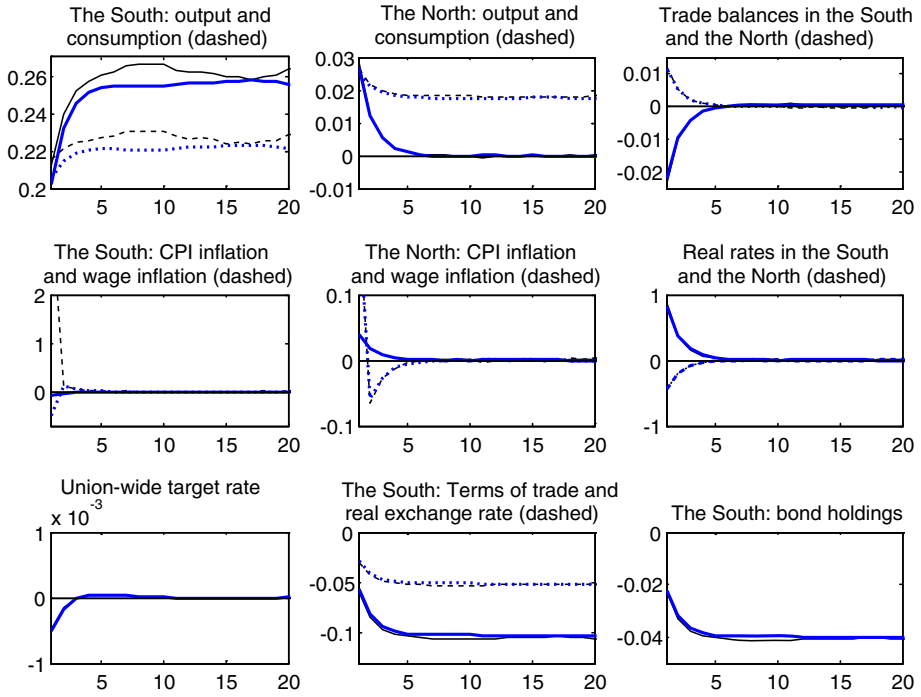
Figure 4 shows the effects of the two types of fiscal devaluations under flexible wages. Lines without markers depict the adjustment to a fiscal devaluation that cuts the SCR (our main exercise), while marked lines depict the impact of a fiscal devaluation that cuts labor income taxes [as in Lipinska and von Thadden (2012)]. As can be seen in Figure 4, both policies lead to a permanent output expansion of about 0.25 percent. The adjustment of real variables is virtually independent from whether additional revenue from the VAT hike is used to reduce labor income taxes or the SCR. The reason is that the adjustment of prices is almost identical under both policies. This is due to the fact that the adjustment of nominal wages—marginal costs—is virtually identical. In both cases, real marginal costs remain almost constant.

If a fiscal devaluation comprises a cut in the SCR, it shifts the nominal tax burden from firms to consumers, who pay a higher VAT. However, under flexible wages, the rise in the VAT is instantaneously compensated by a rise in nominal wages, so that the marginal rate of substitution is not affected. The immediate rise in nominal wages elevates marginal costs such that the reduction in the SCR is offset. Hence, real marginal costs are virtually constant, so the reduction in prices and the resulting expenditure-switching effect are negligible. The observed 0.25 percent increase in output originates from a reduction in distortions, which arises because social contributions are more distortionary than consumption taxes because the VAT tax base is larger than the labor income and SCR tax base.

In the adjustment to a fiscal devaluation that cuts labor income taxes, real marginal costs are almost constant because nominal wages do not change significantly. This is because devaluation does not affect the allocation of the nominal tax burden: The decline in purchasing power that results from the VAT hike is compensated by the reduction in labor income taxes. As a result, nominal

[9] Another difference between Lipinska and von Thadden's (2012) and our approach is their assumption that governments balance their real budgets every period by adjusting labor tax rates every period. We, in contrast, assume that that all government spending is for public transfers to households and that a fiscal devaluation is revenue neutral in the long term. In our model, public transfers in the South increase very mildly in the short term. This implies that our finding that a fiscal devaluation is effective in the short term does not come from lower distortionary taxes that are financed by lump sum taxes or debt in the short term.

Figure 4. Comparing Two Types of Fiscal Devaluations under Flexible Wages



Bold blue lines: Devaluation that cuts labor income taxes. Plain lines: Devaluation that cuts the SCR. Inflation and interest rates are expressed in annualized percentage points and basis point deviations, respectively. Deviations of trade balances are expressed in percentage of the initial GDP. For all other variables, we report percentage deviations from their steady-state values. (Color figure online).

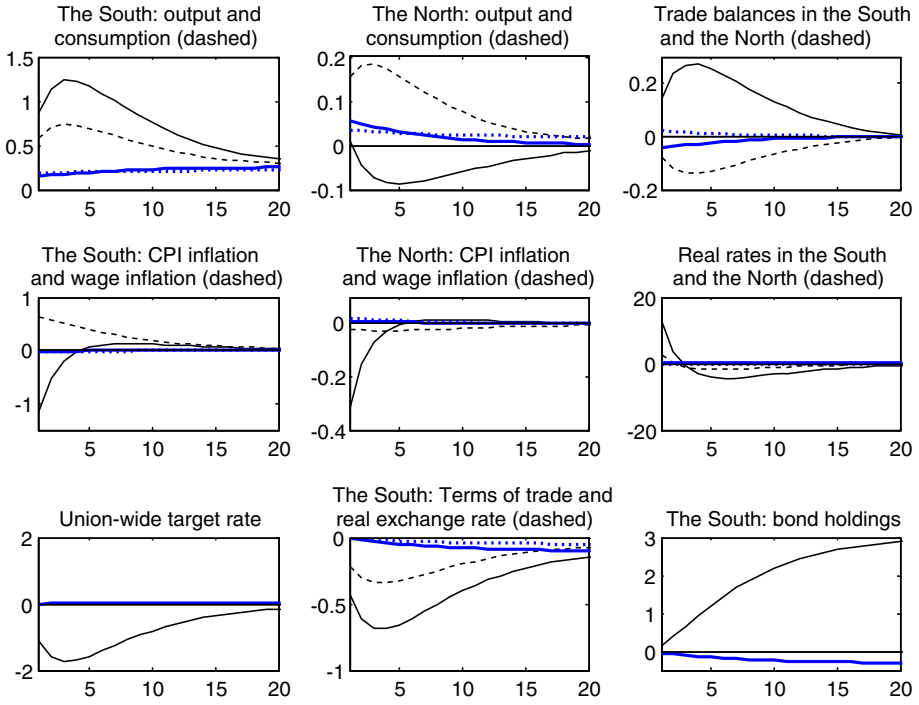
wages are not adjusted. The small but sustained impact on output is again explained by a reduction in distortions.

Model with Sticky Wages

Figure 5 contrasts the impact of the two types of fiscal devaluations in a model with sticky wages. A fiscal devaluation that cuts labor income taxes has roughly the same impact as in the model with flexible wages. In contrast, and as shown in Section 4, the adjustment to a fiscal devaluation that cuts the SCR is dramatically stronger: Output peaks at about 1.2 percent above its steady-state value, so the impact is at its maximum roughly 5 times as large as for the other type of devaluation.

In this version, nominal wages do not immediately adjust when after-tax real wages deviate from their long-term value, i.e., from a markup over the present value of marginal rates of substitution. In particular, when after-tax real wages deviate from their long-term value, labor unions only gradually adjust wages to re-establish the initial markup. This is not consequential for a devaluation that cuts labor income taxes: As explained above, there is no shift of the nominal tax

Figure 5. Comparing Two Types of Fiscal Devaluations under Sticky Wages



Bold blue lines: Devaluation that cuts labor income taxes. Plain lines: Devaluation that cuts the SCR. Inflation and interest rates are expressed in annualized percentage points and basis point deviations, respectively. Deviations of trade balances are expressed in percentage of the initial GDP. For all other variables, we report percentage deviations from their steady-state values.

burden and after-tax real wages remain virtually unchanged, because the labor tax reduction is almost completely offset by the VAT increase. Labor unions, therefore, do not want to change wages anyway. This explains why price stickiness is not crucial for the impact of this type of fiscal devaluation. However, price stickiness matters dramatically for devaluations that cut the SCR. Here, a devaluation shifts the nominal tax burden from firms toward workers and reduces after-tax real wages (due to the VAT hike). While the reduction in purchasing power of workers immediately increases wages in the model without wage rigidity, it only generates willingness of labor unions to increase wages in the model with rigidity, but only limited action. This means that there is no immediate increase in wages, so marginal costs decline on impact by the full amount of the SCR reduction. The VAT hike only gradually feeds into higher wages as more labor unions are allowed to re-adjust wages. Hence, in the composition of marginal costs, the decline in the SCR is only gradually offset by rising wages. As a result, the price decline is dramatically stronger than under a devaluation that cuts labor income taxes. This in turn implies a stronger real devaluation and a more pronounced expenditure-switching effect toward domestic goods.

As further discussed in Section 4.2, some of the differences in results between Lipinska and von Thadden (2012) and ours can be explained by the use of different parameter values.[10] For example, we set cross-country substitutability to 2, whereas Lipinska and von Thadden (2012) set it to 1.5. A higher cross-country substitutability implies that the expenditure-switching effect, which increases the South's output and decreases the North's output in the short term, is higher in our model. However, the above discussion shows that the major difference is the different tax rates on labor employed.

Sensitivity Analysis

In this section, we analyze how sensitive the effects of a fiscal devaluation on the main variables are to changes in key parameter values. Figure 6 and Table 2 show the consequences of varying key parameter values.

Non-Ricardian households

In a first sensitivity analysis, we follow Galí and others (2007) and assume that only a fraction $1 - \lambda$ of households are *Ricardian* (denoted now by superscript R), while a fraction λ of households are *non-Ricardian* (denoted by superscript N) who do not optimize utility intertemporally; they consume their current labor income in each period and they do not own assets nor have liabilities (Ricardian households own firms). The inclusion of non-Ricardian households is justified by several empirical studies. Campbell and Mankiw (1990), for example, find that aggregate consumption can be explained by both permanent and current income. Mian and Sufi (2010) find that credit constraints can explain a large fraction of consumption in a recession. In addition, the euro area suffers from a banking crisis, which harms financial intermediation.

Non-Ricardian households do not intertemporally optimize their behavior. Instead they maximize on a period-by-period basis the utility function

$$U_t^N = \left\{ \log C_t^N - \frac{\left(N_t^N\right)^{1+\emptyset}}{1+\emptyset} \right\}.$$

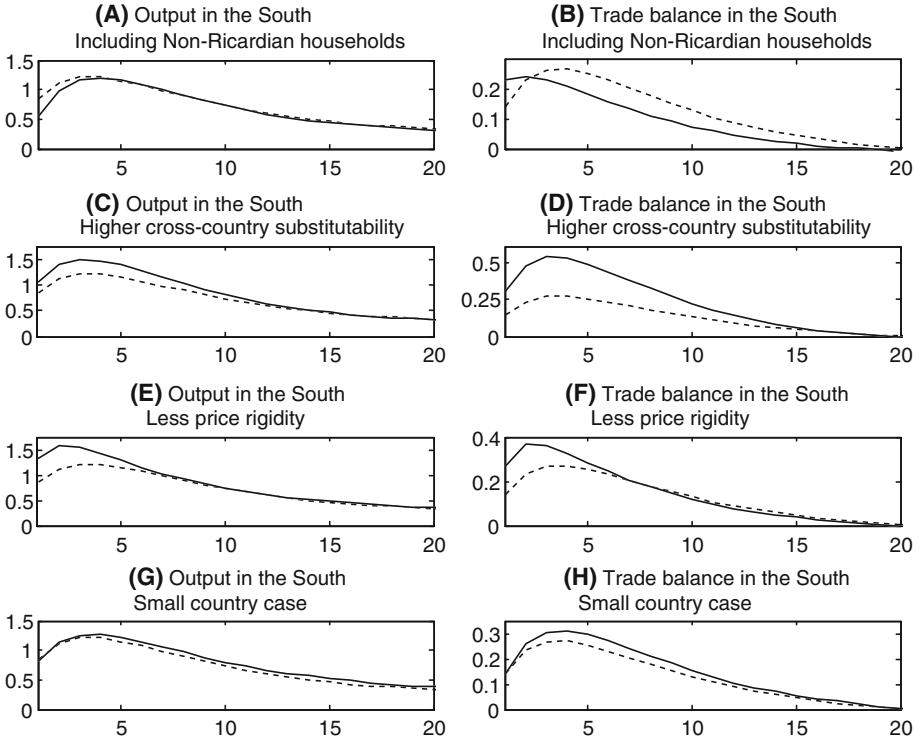
where the consumption index is identical to the basic case. Their budget constraint is given by

$$\left(1+\tau_t^{\mathrm{VAT}}.\right) P_t C_t^N = W_t N_t^N + T_t.$$

and their level of consumption is

[10] In addition, part of the difference in results between our results and those of Lipinska and von Thadden (2012) can be explained by different solution methods. Lipinska and von Thadden (2012) use a first-order approximation, which ignores the cross term, i.e., the change in the tax base times the change in the tax rate. The use of the second-order approximation, in our model, increases the effect of fiscal devaluation on South's output in the short term by 10 percent.

Figure 6. Effects of Varying Key Parameter Values



Solid lines: Adjustment under respective model variation. Dashed lines: Adjustment in the benchmark model.

$$C_t^N = \frac{W_t N_t^N}{\left(1+\tau_t^{\mathrm{VAT}}\right)P_t} + \frac{T_t}{\left(1+\tau_t^{\mathrm{VAT}}\right)P_t}$$

The South's aggregate consumption is $C_t = \lambda C_t^N + (1-\lambda)C_t^R$.

We assume that Ricardian and non-Ricardian households do not differ with respect to their labor market characteristics. We assume that the marginal rate of substitution that unions take into account is a weighted average of both households' marginal rates of substitution between consumption and leisure. Although households can have different levels of consumption, both types work the same number of hours.[11] Therefore, the labor union z's objective is given by

$$\max_{W_t(z)} \sum_{k=0}^{\infty} \beta^k \theta_w^k \mathbb{E}_t \left\{ \left(\frac{1-\lambda}{C_{t+k}^R} + \frac{\lambda}{C_{t+k}^N} \right) \frac{W_t(z)}{\left(1+\tau_t^{\mathrm{VAT}}\right)P_{t+k}} N_{t+k|t}(z) - \frac{N_{t+k|t}^{1+\emptyset}(z)}{1+\emptyset} \right\},$$

and the first-order condition is

[11] Drautzburg and Uhlig (2013) use a similar approach.

Table 2. Consequences of Varying Key Parameter Values

Row	Parameters/ specification	Peak effect on the South's output (%)	Peak effect on the North's output (%)	Peak effect on the South's trade balance (%)	Peak effect on the North's trade balance (%)
1	Benchmark	+1.21 (deviation from the initial EQ)	−0.08	+0. 27 of current GDP	−0.14
2	$\lambda = \lambda^* = 0.5$	+1.2	−0.13	+0.24	−0.12
3	$\sigma = 3$	+1.49	−0.21	+0.53	−0.27
4	$\sigma = 1.5$	+1.03	−0.03	+0.13	−0.06
5	$\theta_p = 0.5$	+1.58	−0.12	+0.36	−0.19
6	$1 - n = 0.05$	+1.26	−0.01	+0.31	−0.01
7	$\omega = 0.25$	+1.17	−0.07	+0.22	−0.11
8	$\emptyset = 2.5$	+1.36	−0.11	+0.33	−0.17
9	$\theta_w = 0.8$, $\theta_w^* = 0.75$	+1.36	−0.09	+0.3	−0.15
10	Different tax pass-through	+0.80	−0.26	+0.63	−0.14

$$\sum_{k=0}^{\infty} \beta^k \theta_w^k \mathbb{E}_t \left\{ N(z)_{t+k|t} \left(\left(\frac{1-\lambda}{C_{t+k}^{RH}} + \frac{\lambda}{C_{t+k}^{NR}} \right) \frac{W_t^O}{\left(1+\tau_t^{\mathrm{VAT}}\right) P_{t+k}} - \frac{\epsilon_w}{\epsilon_w - 1} \left(N(z)_{t+k|t}\right)^{\emptyset} \right) \right\} = 0$$

Figure 6a and rows 1 and 2 of Table 2 show that the effect of a fiscal devaluation on output is only slightly stronger in the short term, when one half of households is non-Ricardian ($\lambda = \lambda^* = 0.5$). Non-Ricardian households consume their current labor income in each period. The rise in nominal wages, the fall of prices, and the increase in employment (see Figure 3) that last for several quarters dominate the income reducing effect of the increase in the VAT. Non-Ricardian households' real income and consumption increase for five quarters after the change in taxes. The initial increase in consumption, however, is relatively muted when compared with the Ricardian households, as Figure 3 illustrates. The reason is that the increase in income evolves slowly due to the staggering price and wage changes. A conclusion is that the *short-term* effectiveness of a fiscal devaluation is slightly weakened by the presence of non-Ricardian households when prices and wages need time to adjust. Our finding is consistent with Boscá and others (2012) who find that when the share of non-Ricardian consumers gets larger, the output effect of a fiscal devaluation becomes weaker.

Cross-country substitutability

Empirical estimates on cross-country substitutability vary and the international economics literature uses a wide range of parameter values for it. Row 3 of Table 2 and Figure 6c show the higher cross-country substitutability, the higher

the output and trade balance effect of a fiscal devaluation. The fact that the South's and the North's goods are now better substitutes implies that the expenditure-switching effect is stronger. This increases the South's output and decreases the North's, when compared with the benchmark case. A higher increase in the South's output means that their households have more extra income in the short term. Consequently, the accumulation of international assets becomes stronger and the effect of a fiscal devaluation on the trade balance increases strongly.

The earlier literature has found that the output effects of a fiscal devaluation are robust to changes in the value of cross-country substitutability. European Commission (2006) finds that raising it from 2 to 5 increases the effect of a fiscal devaluation, in which labor income taxation is cut, on long-term output only from 0.2 to 0.24 in Germany. However, cross-country substitutability—most of all—governs the strength of the expenditure-switching effect in the short term. The long-term focus is therefore somewhat misleading. Boscá and others (2012), however, find that even short-term output effects are robust to values of cross-country substitutability. They show that doubling cross-country substitutability has virtually no impact on accumulated GDP after two years in Spain. In this paper, we show that the effects of a fiscal devaluation on output are more sensitive to the value of cross-country substitutability than the earlier literature has found.

Row 4 of Table 2 shows the effects of a fiscal devaluation in a case where cross-country substitutability is set to 1.5, as in Lipinska and von Thadden (2012). A low cross-country substitutability implies a weaker expenditure-switching effect. Therefore, the increase in the South's output becomes weaker. We, however, still find a much stronger effect on output than Lipinska and von Thadden (2012).

CPB (2013) finds that the trade balance effects of a fiscal devaluation are robust to values to cross-country substitutability. Doubling cross-country substitutability has a minor quantitative impact on the trade balance. In our model, however, doubling cross-country substitutability from 1.5 to 3 increases the peak effect of a fiscal devaluation on the South's trade balance by 44 percent. We can therefore conclude that the effect of a fiscal devaluation on the trade balance is much more sensitive to the value of cross-country substitutability than the earlier literature has found.

Price rigidity

Figure 6e and 4 and row 5 of Table 2 show the consequences of varying the degree of price rigidity. In an alternative setup, we set the price rigidity parameter to 0.5, implying an average delay of 6 months between price adjustments. This is consistent with the estimates of Bils and Klenow (2004). In this case, prices are more flexible. In the short term, a larger fraction of firms has an opportunity to lower prices and take the cost advantage of a reduction of the SCR rate. In the short term, a fiscal devaluation lowers the relative price of the South's goods by more than under the benchmark parameterization. Therefore, a stronger

expenditure-switching effect explains a stronger increase of the South's output in the short term. The policy implication of this is that goods market reforms that foster price flexibility render fiscal devaluations more effective. On the other hand, as prices are more flexible, the expenditure-switching effect fades away faster than under the benchmark parameterization.

Country size

The next step is to investigate the role of the country size. CPB (2013) argues that improving the competitiveness by a fiscal devaluation in one country happens at the expense of the competitiveness of another country. The beneficial effects on the trade balance get smaller if a fiscal devaluation is carried out in several countries at the same time. We analyze the small-country case by setting the relative size of the country that carries out fiscal devaluation to 5 percent ($1 - n = 0.05$). The assumption that the per-capita level of output and consumption is identical across regions implies that the share of imported goods in the rest of the euro area must be changed to 1.7 ($\omega^* = 0.017$).

Figures 6g, h and row 6 of Table 2 show that a fiscal devaluation carried out in a small country increases the domestic output by more than in the benchmark case. This finding is consistent with that of CPB (2013). CPB (2013) finds that the unilateral implementation of a fiscal devaluation is the best option for a country that wants to expand its GDP. The output effects become less favorable when several countries implement fiscal devaluations in a coordinated way.

Openness

Next, we analyze the role of the degree of openness. As discussed in Section 3, we set the share of imported goods in the 'Southern European countries' consumption basket to match the empirically observed import-to-GDP ratio. In comparison, Lipinska and von Thadden (2012) set the share of imported goods to 25 percent in both countries (that are of equal size). In an alternative scenario, we set $\omega = 0.25$ which implies that the share of imported goods in the North's consumption basket (ω^*) must be changed to 0.13 percent. Lipinska and von Thadden (2012) show that the introduction of home bias slightly dampens the effect of a fiscal devaluation on output in the long term. Row 7 of Table 2 shows that our findings complement their findings. In a more closed economy, the expenditure-switching effect is smaller and consequently the effect of a fiscal devaluation becomes weaker in the short term.

Labor supply elasticity

A potentially important parameter is the Frisch elasticity of labor supply. Lipinska and von Thadden (2012) set it to 0.4, whereas we set it to one in our benchmark parameterization. In an alternative scenario, we set $\emptyset = 2.5$. This

implies that the Frisch elasticity, which is $1/\emptyset$ in our model, is 0.4. Row 8 of Table 2 shows that the lower the Frisch elasticity, the weaker the output effect of a fiscal devaluation. However, also in the alternative scenario, we find a much stronger output effect than Lipinska and von Thadden (2012).

Labor market asymmetries across regions

Druant and others (2009) find that the average duration of wages is roughly four quarters in the North (now Austria, Belgium, France, and the Netherlands) and roughly five in the South. For this reason, we analyze the consequences of labor market asymmetries across regions by setting the Calvo parameter for wages in the South to 0.8, implying an average delay of five quarters between wage adjustments and keep the value at 0.75 for the North as in the benchmark calibration. Row 9 of Table 2 shows that this makes the output effect of a fiscal devaluation stronger. The reason for this finding is that the bigger degree of wage rigidity in the South further dampens the effect of the VAT rate increase on wages allowing a bigger fall in marginal costs and thus a stronger fiscal devaluation.

Tax pass-through

In our baseline specification, we assumed that firms' price setting is exclusive of the VAT in the sense that consumers pay the VAT, while firms are only indirectly affected through its effect on aggregate demand for goods and on wage setting. Moreover, it implies that pass-through of the VAT on consumer prices is complete in the first period. We next present a slightly different setup where firms pay the VAT when goods are sold domestically, while consumers continue to pay it on imports. Therefore the price setting decision is directly affected by the VAT of the firms' respective home economies, while they do not consider the respective foreign VAT which is paid on exports by foreign consumers.

This modification affects the profit function and whereby the price setting equation of firms and the household's budget constraint. Southern firm i's profit function now reads

$$\Pi_t(i) = \left(1 - \tau_t^{\mathrm{VAT}}\right) P_t^S(i) Y_t^{SS}(i) + P_t^S(i) Y_t^{SN}(i) - \left(1 + \tau_t^{\mathrm{SCR}}\right) sw_t W_t N_t(i)$$

where $Y_t^{SS}(i)$ and $Y_t^{SN}(i)$ are the firm's domestic and foreign sales, respectively. Because now the firm pays the domestic VAT, the price it charges implicitly takes account of it.

The budget constraint of the South's household is

$$B_{t+1} + P_t^S C_t^S + \left(1 + \tau_t^{\mathrm{VAT}}\right) P_t^N C_t^N = R_{t-1} B_t + W_t N_t + \Pi_t + T_t.$$

The last line of Table 2 shows the effects of a fiscal devaluation. The peak output effect is about 0.8 percent and smaller than in the benchmark case. This is the result of two effects working in opposite directions. First, the inclusion of the

South's VAT in the firms' price setting equations tends to increase the optimal price after the shock because firms' profits from sales in the South fall when the VAT rises. This effect works directly against the price reducing effect of the SCR reduction. This effect is, however, muted because of the Calvo mechanism. Second, the increase in the South's VAT increases the price of imported goods from the North. This effect is not muted by the Calvo mechanism so that the relative price of the South's domestic goods falls strongly incurring expenditure-switching by the South's consumers away from the North's goods to domestic goods. The latter effect is dominated by the first one, so that the peak effect is smaller. However, the output effect remains sizable. But note that the trade effect is significantly larger now implying that the second effect has a sizable impact on the terms of trade.

Conclusion

Correcting the loss of competitiveness in the South and the current account imbalance between the North and the South are challenging jobs for the euro area. We find that a fiscal devaluation in the South depreciates its real exchange rate and improves its trade balance. The advantageous short-term effects of a fiscal devaluation, however, should not be overemphasized: a fiscal devaluation, under the benchmark parameterization, depreciates the real exchange rate by 0.3 percent and improves the trade balance by 0.3 percent of GDP, which are quite small effects. Our findings therefore suggest that a fiscal devaluation alone would not be sufficient to correct the divergence in competitiveness and the current account imbalance between the South and the North of the euro area. A fiscal devaluation should however be part of a wider package of economic policy reforms aimed at increasing the competitiveness of the South, including product and labor market reforms and wage moderation, for instance.

In our model, a fiscal devaluation is much more effective in terms of stimulating domestic short-term output than earlier models have found. We found that—assuming sticky wages—a fiscal devaluation, of 1 percent of GDP, increases the level of output in the South by 0.8–1.6 percent, depending on the parameterization. Furthermore, a fiscal devaluation entails a structural improvement, because it has a positive effect on output in the long term. Our findings suggest that a fiscal devaluation could be used as a part of a policy package aimed at increasing output in the South.

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