Fiscal Devaluation and Relative Prices:

Evidence from the Euro Area

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Abstract

Fiscal Devaluation has long been proposed as a policy option to improve competitiveness, especially for those countries that cannot rely on a nominal depreciation. The literature on the economic effects of this policy focused mainly on net exports, disregarding the direct impact on relative prices. The aim of this paper is to provide empirical evidence on the effects of a revenue neutral shift from labour to consumption taxes on both the real effective exchange rate and the terms of trade. We estimate a dynamic econometric specification for a panel of euro area countries, using as indicators of tax structure both implicit tax rates and tax ratios, and explicitly accounting for the heterogeneity and cross-sectional dependence. When tax ratios are used, our results weakly corroborate with the expected effects that a fiscal devaluation should bring out in the short run.

Keywords: fiscal devaluation, exchange rate, terms of trade, internal competitiveness

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1. Introduction

Competitiveness is a key issue for each country of the euro area. Member states show substantial differences in terms of competitiveness with respect to their trading partners. Before the introduction of a common currency, changes in nominal exchange rates would have helped to restore member countries' competitiveness. Within a Monetary Union, a unilateral devaluation of the nominal exchange rate is no longer feasible.

The literature has long recognized that the effects of a nominal devaluation might be indirectly achieved, when prices are sticky, through revenue neutral tax shifts usually referred to as "internal" of "fiscal" devaluation. Keynes (1931) argued that the combination of an import tariff and an export subsidy may lead to a raise in the domestic price of importable and to a reduction in the foreign price of exportable. More recently, Farhi et al. (2014) show that a mix of consumption and labour taxes can replicate the real allocation reached under a nominal exchange rate devaluation.

The policy debate in Europe has focused in particular on a fiscal devaluation realized through a reduction in employers' social security contributions (SSCs) compensated by an increase in the value added tax (VAT) rate. This policy has been supported by the Commission's reform recommendations to Member States in context of European Semester. The European debate has been also echoed in the United States discussion of the destination-based cash flow tax. In fact, as argued by Auerbach et al. (2017), a destination based-income tax would bring about the same economic effects of a raise in the VAT rate compensated by a corresponding reduction in taxes on wages and salaries.

Despite the advances in the theoretical analysis, the empirical evidence on the fiscal devaluation is scant. The existing empirical analyses focus on the effects of a change in the tax mix on quantities, usually net exports, disregarding the impact that the tax policy has on international relative prices. The theory suggests that a fiscal devaluation will exert its effects on the trade balance by affecting the terms of trade (TOT) and the real effective exchange rate (REER). An extensive literature has investigated the determinants of both the TOT and the REER but it has neglected the potential impact of a tax shift.

This paper aims at bridging the gap between the literature on fiscal devaluation and the literature on the determinants of international relative prices, by providing empirical evidence on the effects of a tax shift from SSCs to VAT on both the TOT and the REER when the nominal exchange rate is fixed. Our estimation strategy allows to identify long-run and short-run effects and accounts for the presence of both observed and unobserved heterogeneity across countries.

Overall, our results confirm that a unilateral shift from SSCs to VAT does not affect the international relative prices in the long-run. However, contrary to the theoretical prediction, we do not find strongly significant effects of a fiscal devaluation even the short-run. We also find that the impact of a shock in the tax mix on TOT and REER is heterogeneous across countries.

The remainder is organized as follows. Section 2 reviews he theoretical background and the existing empirical literature related to our analysis. In section 3, we outline the empirical strategy and the econometric specification, while section 4 describes the data. Section 5 reports the results and finally, section 6 concludes the paper.

2. Theoretical background and empirical evidence

The literature has highlighted several channels through which domestic taxes may affect the nominal exchange rate, the capital account and the trade balance (Arachi and Alworth 2010). Two policies in particular have been proposed as a means to replicate the effects of a nominal devaluation. The first one, originally suggested by Keynes (1931), is given by an ad-valorem tariff on all imports coupled with a uniform subsidy on all exports. The second one, on which we focus in this paper, is based on a cut in payroll taxes (e.g. social security contributions) compensated by an increase in the tax burden on workers and households. Calmfors (1993, 1998) first argued that a cut in payroll taxes at an unchanged fiscal balance will have the same short-run effects on output and employment as a nominal exchange rate devaluation, in a static model with a fixed capital stock and nominal wage rigidity. The similarity between a nominal and fiscal devaluation is most clear when the revenue loss of a reduction in social contributions paid by employers is compensated by an increase in VAT. For a fixed money wage, a cut in payroll taxes lowers the labour cost relative to foreign prices measured in domestic currency in the same way as a nominal exchange rate devaluation. To the extent that lower labour costs are reflected in lower prices for domestically produced commodities, the tax shift from payroll taxes to VAT will leave the purchasing power in terms of domestic goods unaffected while the import prices will increase. As in the case of a nominal devaluation, employee will then experience a loss of purchasing power in terms of imports.

More recently Farhi et al. (2014) clarified the conditions under which a fiscal devaluation implemented through a revenue-neutral tax shift from payroll taxes to VAT can replicate the same real equilibrium allocations attained under a nominal exchange rate devaluation in a dynamic New Keynesian open economy model. Both a nominal and a fiscal devaluation affect the equilibrium allocations by changing two international relative prices: the terms of trade and the real exchange rate.

The terms of trade (*TOT*) is defined as the ratio of the export price index (P_X) to the import price index (P^*_M) (inclusive of VAT):

$$TOT=\frac{P_X(1-\tau_v)}{P^*_M}\mathcal{E}.$$

where an asterisk denote variables in foreign currency, τ_v the VAT rate and $\mathcal{E}$ is the nominal exchange rate, defined as the price of one unit of home currency in terms of units of the foreign currency (hence an increase in $\mathcal{E}$ represents a home currency appreciation). The real exchange rate is defined as the ratio of the foreign (P^*) and the domestic (P) price index:

$$REER=\frac{P}{P^*\mathcal{E}}.$$

These relative prices affect two key equilibrium conditions: the terms of trade shape the trade balance in a country budget constraint while the real exchange rate influences the equilibrium in the world asset market by affecting savings and portfolio choices. Farhi et al. (2014) show that a revenue neutral shift from payroll taxes to VAT generate the same movement in the terms of trade (TOT) of a nominal devaluation. The sign of the short-run impact will depend on whether firms set the same price in the producer currency in the domestic and the foreign market (*producer currency pricing*) or if they set both a home market price in home currency and foreign-market price in the foreign currency (*local currency pricing*). An increase in VAT coupled with a reduction in the payroll tax would live unchanged the wedge in the home price setting. Under producer currency pricing, the increase in the VAT rate will reduce the relative price of home export to home imports as the tax is levied on home consumers of foreign goods and reimbursed to home exporters (that can then charge a lower price in the foreign market). Under local currency pricing, in contrast, the tax shift leads to a short-run appreciation of the TOT (Farhi et al. 2014).

The equivalence between a revenue neutral shift from payroll taxes to VAT and a nominal exchange rate devaluation does not hold with respect to the real exchange rate. The real exchange rate depreciates following a nominal devaluation, whereas it appreciates following a tax shift towards VAT as the home price level increases with respect to the foreign one. It follows that a fiscal devaluation implemented through a revenue-neutral tax shift from payroll taxes to VAT can exactly replicate the real effects of a nominal devaluation only when the dynamics of the REER does not affect the equilibrium allocation. This is the case when the devaluation is unexpected and assets markets are incomplete since under these circumstances a one-time unanticipated jump in the REER would affect neither savings nor portfolio decisions. When asset markets are complete and the policy change is anticipated, savings and portfolio decisions would be differentially affected by the tax shift due to the foreseen appreciation of the REER. In this case, in order to replicate a nominal exchange rate devaluation the shift from payroll taxes to VAT should be complemented with the introduction of a consumption subsidy coupled with a proportional increase of the labour tax. The consumption subsidy offsets the relative increase in the home price level but it would distort the wage setting and labour supply decisions. The latter distortion could be undone by a proportional labour income tax.

More recently, Erceg et al. (2017) highlight that the results in Farhi et al. (2014) are highly sensitive to the assumption that consumer prices are sticky inclusive of VAT. If prices are sticky in pre-tax terms, a fiscal devaluation will lead to an increase in consumer prices of the domestic good in the home market, which would limit any depreciation of the TOT and further enhance the REER appreciation.

In any case, the effects of a fiscal devaluation are deemed to be temporary as they should vanish once prices adjust and in the long-run both TOT and REER will return to their pre-devaluation level.

2.1. Empirical evidence

Existing studies on the economic effects of fiscal devaluation focus mainly on the impact on GDP, employment and trade balance, analysing both the short and the long run effects. They can be classified in two groups. The first group consists in simulation-based studies that rely on a theoretical general equilibrium model. Annicchiarico et al. (2014) study the potential effect of fiscal devaluation on the Italian economy using IGEM, a dynamic general equilibrium model developed at the Italian Department of the Treasury. Engler et al. (2013) calibrate a DSGE model to the euro area and show that a fiscal devaluation carried out in southern european countries has strong positive effect on output, but a mild effect on their trade balance, while there is a weak negative effect on output of central-northern countries. Lipinska and von Thadden (2012) use a two-country New Keynesian model of a monetary union, to show that the effectiveness of a fiscal devaluation crucially depends on the degree of financial integration between the two countries.

The second group includes a series of empirical investigations on panel data. Some of them document a correlation between taxes and trade. Lane and Perotti (1998, 2003) analyse the effect of labour taxes on net export and output, but they disregard consumption taxes. Keen and Syed (2006) estimate the impact of VAT and corporate taxes on net exports, finding that the mix between the two matters significantly for the trade balance in the short run, however they do not look at labour taxation. Few empirical studies try to directly assess the effects of a shift from social security contribution to consumption taxes on trade performance. One of the earliest work in this sense is Arachi and Alworth (2010). They find that net exports of OECD countries are not significantly affected by VAT while social contributions have a negative effect (albeit weakly significant) for EMU country after the introduction of the euro. More recently De Mooij and Keen (2013) estimate an error correction model for a panel of thirty OECD countries between 1965 and 2009 and find that a revenue-neutral shift from employers' social contribution towards the VAT in euro area improve the trade balance in the short run. In the long run, the effects would vanish and can even turn into negative.

By focusing on the effects on trade, existing studies do not shed light on the channels through which taxes impact the real economy. The theory suggests that trade balance will be affected by the changes a tax policy brings about in the TOT and the REER, but little is known on both the actual impact of taxes on international relative prices and on the ensuing effects on imports and exports.[1] We attempt to bridge this gap by estimating the effect of a revenue neutral shift from social security contributions to VAT on both the TOT and REER. Our analysis is therefore related to the literature on the economic determinants of REER and TOT.

Candelon et al. (2007) estimate the determinants of bilateral equilibrium exchange rates against the euro for the eight countries that joined the European Union as of May 2004 in order to assess the readiness of countries to move to the monetary union. They document a significant positive link between productivity and the REER and a negative impact of trade openness. For the demand indicators they find less robust results, in particular the coefficient for the government consumption is not statistically significant. Ricci et al. (2013) find slightly different results. They apply the dynamic ordinary least squares (DOLS) methodology to estimate the equilibrium cointegrating relationship between the relative price index and the set of its fundamentals for a group of advanced and emerging markets. They show that an increase in government consumption expenditure causes a significant appreciation of the real effective exchange rate.

Other studies focused on the effect of public spending shocks on price competitiveness using VAR models. Bénétrix and Lane (2013) look at the composition of government expenditure for a panel of euro area countries, finding that the effects on the REER differ across different types of spending with shocks to public investment generating larger and more persistent real appreciation than shocks to government consumption. De Castro and Garrote (2015) find that an expansionary fiscal policy in the euro area leads to real exchange rate appreciations and to a fall in net exports, jointly with lower primary budgetary surpluses, in line with the "twin deficit" hypothesis.

As to the determinants of the TOT, a common view in trade and growth theory is that the terms of trade should deteriorate after a rise in the supply of domestic goods since the increased domestic supply could be absorbed by international markets at falling prices. Stronger internal demand could, instead, appreciate the country' terms of trade, given that it reduces a country's supply of exports. The empirical evidence about the dynamics of the terms of trade is mixed and sometimes it departs from theoretical predictions. Acemoglu and Ventura (2002) document a positive

[1] Kangur (2018) survey the recent literature that has estimated the impact of international relative prices on export developments and find that the results are sensitive to the indicator used to measure competitiveness and to the country investigated.

correlation between terms of trade and human capital, taken as a proxy for product innovation. The analysis by Ghironi and Melitz (2005) under a DSGE framework shows that the terms of trade increase after productivity shocks. In a VAR analysis, Corsetti et al. (2006) show that the international relative prices' response to productivity shocks is heterogeneous across countries. They find that the terms of trade depreciate in Italy and the UK, while appreciating in the US and Japan. Corsetti et al. (2007) provide evidence that the terms of trade deteriorate in response to an increase in productivity that lowers marginal costs in production. From the demand-side, Monacelli and Perotti's (2008) analysis based on structural VAR evidence for the US, documents that a rise in government spending generates a fall in the relative price of imports, and thus, an appreciation of the terms of trade. Similar results stem from the analysis by Enders et al. (2011).

3. Empirical strategy and model specification

Our empirical strategy cope with several concerns related to the framework analysed. First, when studying the impact of fiscal shocks it is important to choose how to measure exogenous variations in the tax system. The most obvious way is to use the main statutory tax rates. However, in our case they are inappropriate since it could be better to focus on variation in the effective tax burden, and statutory rates do not capture changes in tax bases. Some authors rely on aggregate measures of the average tax burden, such as the share of one type of tax in total revenue, called tax ratios (Arnold et al. 2011, Xing 2012). As argued by Arachi et al. (2015) however, the main drawback of the latter is that in the long run they are likely to be affected by endogeneity issues. To overcome this concern, macro-level effective tax rates, also called 'implicit tax rates' by the European Commission (2013) has been suggested (Mendoza et al., 1997). Implicit tax rates are computed as the ratio between the share of tax revenue that is raised from a given tax and its potential tax base. The advantage of using the latter is that implicit tax rates can be immediately interpreted since they represent the tax wedge distorting optimizing behaviour in a representative agent setting. Moreover, compared to tax ratios, they are less directly affected by the development in factor shares (Arachi et al. 2015). To allow a ready comparison with the previous literature we perform our analysis using alternatively both implicit tax rates and tax ratios. We focus on fiscal devaluation realized through a shift from SSCs to VAT for a given level of revenue. A tax reform of this kind would increase the ratio between the wedges due to VAT and SSCs respectively (as measured by either tax ratios or implicit tax rates) and leaved unchanged the ratio between total revenue and GDP.

The theoretical literature suggests that a fiscal devaluation would affect international relative prices only when it is implemented by a single country against the trading partners. For this reason, we insert in the regression the variable tax-mix that measure the ratio between the relative wedge of VAT vs SSC in a given country and the weighted average of relative wedges in trading partner countries. As a consequence, the tax-mix increases if a country shifts the tax burden from labour to consumption, given unchanged tax policies by competitors countries. We use revenue over GDP to control for the overall tax burden.

The literature also suggests that it is important to distinguish between the short and the long run. A fiscal devaluation may improve a country trade competitiveness in the short run with sticky prices, whereas the effects could vanish in the long period because of price adjustment (De Mooij and Keen, 2013). Due to these considerations, after investigating the possible presence of unit roots in the series by means of first and second-generation panel unit root tests, we decided to model the short and the long run dynamics using an Error Correction Model (ECM). At least three specifications of the ECM can be tested according to the homogeneity restrictions imposed on the short and the long run coefficients. Some authors involved in the analysis of both, fiscal devaluations and relative prices' determinants, point to the presence of heterogeneous effects across countries (Corsetti et al. 2006, Engler 2013). For this reason, we first run regressions assuming perfect poolability of coefficients across the units in the panel, and then we relax this restriction.

A weakness of previous studies is that they largely disregard the possible presence of cross-sectional dependence in the panel. Our contribution in this sense is to estimate an econometric specification that explicitly addresses the presence of unobservable common factors controlling for the cross-sectional dependence.

Turning to the analysis, as a preliminary step we test for non-stationarity of the (log) of the REER, the (log) of the TOT and of the set of explanatory variables included in the empirical model. Table 3.1 shows the statistics from three alternative panel unit root tests. The first column reports the results from the Im, Pesaran and Shin (2003) (IPS) test, under the null hypothesis that all panels contain unit root. Then we report the Maddala and Wu (MW, 1999) statistic, which tests the null that the series are integrated of order 1 under the assumption of cross-sectional independence. Since we cannot exclude the presence of cross-sectional dependence across the units in the panel, we perform a unit root test that takes into account this feature. We thus check for non-stationarity in the series using a second-generation test proposed by Pesaran (2007). This is the cross-sectional augmented panel unit root test, also called CIPS, designed for analysis of unit root in heterogeneous panel setups with cross-sectional dependence.

In table 3.1, we report p-values from the tests performed on both, the variables in levels and first differences.

[Insert table 3.1 here]

Overall, the tests do not reject the null hypothesis of unit root for the variables in levels, whereas, when we perform the tests on first differences, we can conclude for stationarity. Since these tests indicate that the series may be cointegrated, the empirical analysis is performed by estimating an ECM in the form:

$$\Delta P_{i,t} = - \varphi_i \left(P_{it-1} - \sum_v \beta_i^v X_{it}^v - \sum_m \beta_i^m F_{it}^m \right) + \sum_v b_i^v \Delta X_{it}^v + \sum_m b_i^m \Delta F_{it}^m + z_t + \delta_i + \varepsilon_{i,t}, \qquad (1)$$

where i and t index, respectively, country and time. $P_{i,t}$ represents alternatively the two international relative prices analysed in this paper. X_{it}^v and F_{it}^m represent, respectively, the vector of non-fiscal and fiscal variables which are assumed to affect relative prices. The vector of non-fiscal determinants X_{it}^v includes productivity, a measure for the net foreign asset of a country and the interest rate. In particular, productivity is the labour productivity index per person, given by the GDP over total employment; the net foreign asset position is proxied using the variable CAB, which measure the current account balance as a percentage of GDP; the monetary variable considered is the long-term interest rate on government bonds. The vector of fiscal variables F_{it}^m includes government spending, total revenues and the tax-mix, a variable computed using the ratio between VAT and SSCs tax wedges. Since only differential changes should matter, in the regressions we consider the latter variable in relative terms, taking the ratio between the tax-mix for country i and the weighted average of partner countries' values. Finally, we also control for a global factor, given by the real world GDP growth rate, which enters the model as an exogenous variable. δ_i is the country specific intercept and finally, $\varepsilon_{i,t}$ is the error term. Time effects, z_t are captured by a dummy variable for the economic crisis, which takes value 1 from 2008Q1 to 2011Q4.

The econometric approach considered allow us to distinguish between the long run relative prices path and the short run convergence dynamics. The parameters β_i^v *and* β_i^m show the long run equilibrium relationship between each international relative price and the vector of its fiscal and non-fiscal determinants. The contemporaneous impact of an increase in each fiscal and non-fiscal control is given by the coefficient on the differenced variable, b_i^v and b_i^m. The empirical strategy adopted enables us to impose different homogeneity restrictions both on the long run and on the short run parameters.

The term in round brackets in equation (1) represents the candidate cointegrating relationship we seek to identify in our panel time series approach. By relaxing the common factor restriction implicit in the nonlinear relationship between parameters in equation (1), the model can be parameterized as follows:

$$\Delta P_{i,t} = \pi_i^c P_{it-1} + \sum_v \pi_i^v X_{it}^v + \sum_m \pi_i^m F_{it}^m + \sum_v b_i^v \Delta X_{it}^v + \sum_m b_i^m \Delta F_{it}^m + z_t + \delta_i + \varepsilon_{i,t}. \quad (2)$$

Long run parameters can be calculated from the coefficients on the terms in levels π_i^v, since $\beta_i^v = -\frac{\pi_i^v}{\pi_i^c}$ and $\beta_i^m = -\frac{\pi_i^m}{\pi_i^c}$. The coefficient $\pi_i^c = -\varphi_i$ measures the speed of convergence of the economy to its long run equilibrium. Inference on this parameter will provide evidence of the presence of a long run equilibrium relationship, if this parameter is null there is no cointegration, and the model reduces to a regression with variables in first differences. Otherwise, if $\varphi_i \neq 0$ variables in round brackets in equation (1) are cointegrated, and after a shock, the economy returns to the long run equilibrium path.

Finally, in order to control for unobservable as well as for omitted elements of the cointegrating relationship, we follow the Common Correlated Effects (CCE) approach suggested by Pesaran (2006) and employ cross-section averages of all variables in the model. This approach allows each country to have its own slope coefficients both on the observed explanatory variables and on the unobserved common factors. The estimation equation is thus:

$$\begin{aligned}\Delta P_{i,t} = {} & \pi_i^c P_{it-1} + \sum_v \pi_i^v X_{it}^v + \sum_m \pi_i^m F_{it}^m + \sum_v b_i^v \Delta X_{it}^v + \sum_m b_i^m \Delta F_{it}^m + \sigma_i^c \bar{P}_{it-1} + \\ & + \sum_v \sigma_i^v \vec{X}_{it}^v + \sum_m \sigma_i^m \vec{F}_{it}^m + \lambda_i \Delta \bar{P}_{it-1} + \sum_v \lambda_i^v \Delta \vec{X}_{it}^v + \sum_m \lambda_i^m \Delta \vec{F}_{it}^m + z_t + \delta_i + \varepsilon_{i,t}. \quad (3)\end{aligned}$$

The CCE approach has been shown to be robust to different types of cross-section dependence of errors, possible unit roots in explanatory variables, and slope heterogeneity (Pesaran and Tosetti 2011; Chudik et al. 2011). Recent work of Chudik and Pesaran (2015) highlights that in a dynamic panel, and/or in the presence of weakly exogenous variables as regressors, this approach is subject to bias. The authors suggest that the CCE approach continues to be valid if a sufficient number of lags of cross-section averages are included in equation (3).

In the analysis, we first adopt the standard CCE estimator in the mean group version (CMG) employing robust regression in the computation of the coefficient averages, and then we run the regressions to correct the CCE approach, following the suggestion of Chudik and Pesaran (2015).

4. Data

We combine different data sources to obtain a cross-country panel dataset and perform the analysis for 14 euro area countries[2] over the period ranging from 2002 to 2016 with quarterly frequency. Our sample consists of a group of member states, since our interest here is in the effect of a shock in the tax mix for countries that shared a fixed nominal exchange rate.

The analysis is first performed on the CPI deflated REER and then, replicated for the terms of trade (TOT), both computed vis-à-vis the rest of EA countries. [3]

To calculate the variable tax-mix for each country we use the weighted average of relative tax wedges in partner countries. Aggregation is done by geometric average, using overall time varying trade weights (taking into account third market effects) provided by Eurostat.[4]

The numerator of the effective tax rates are given by the revenue of VAT and SSC by Eurostat. Implicit tax rates are obtained by taking the ratio with sum of private and government consumption

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[2] The countries considered are: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Luxembourg, Netherlands, Portugal, Slovakia and Spain. We do not include Estonia, Cyprus, Malta, Lithuania and Slovenia because of lack of data availability.

[3] For both, the REER and the TOT an increase in the index is considered as an appreciation of the relative price.

[4] The same weights are used to construct the real effective exchange rate.

from Eurostat National Accounts for VAT, and a proxy for the labour income for SSC. Tax ratios are obtained by dividing revenues from each tax by total tax revenues.

Since our focus is on a revenue-neutral tax shift, we control in the estimations for the overall tax burden over GDP (T).

Our empirical specification considers some variables suggested by the literature as relative prices' determinants. The first factor is the labour productivity. The impact of productivity is expected to follow the Balassa-Samuelson mechanism, which states that relatively larger increases in productivity in the traded goods sector in a country should be associated with a real appreciation of the currency of that country. On the other hand, a productivity increase simultaneously lower the international relative price of domestic tradables (i.e. it should worsen the country's terms of trade). Alternative measures can be used to consider diverging productivity trends (Égert et al. 2006, Ricci et al. 2013). Here we focus on the logarithm of the labour productivity per person (Y), measured by the GDP over the number of employees.

Because of portfolio-balance considerations, we include a proxy for the outstanding stock of foreign assets as a determinant of the international relative prices. A deficit in the current account leads to an increase in the net foreign debt of a country, which has to be financed by international diversifying investors that for the associated adjustment demand higher yield. At given interest rates, this may lead to a depreciation of the currency of the debtor country. Moreover, a current account deficit accumulates net foreign debts for which interests has to be paid, and interest payments need to be financed by increasing the attractiveness of its exports. The variable CAB, which measures the current account balance as a percentage of GDP is included in the list of the relative prices' predictors (Maeso-Fernandez et al. 2002, Comunale, 2015).

The relationship with the fiscal balance is also considered to be of interest, as it constitutes one of the key components of national savings. A fiscal tightening causes a permanent increase in the net foreign assets position of a country and, consequently an appreciation of its exchange rate in the longer term. Furthermore, intertemporal business cycle models predict that exogenous increase in government spending leads to significant terms of trade movements (Corsetti et al., 2007). We control for these potential effects by including in the regression government expenditure (G), computed as the sum of government consumption and government investment, divided by GDP. In order to account for the development in the monetary policy we consider in the analysis the long-term interest rate on government bonds (I). (De Castro and Fernández, 2013; De Castro and Garrote, 2015)

All variables are seasonally adjusted using the TRAMO/SEATS methodology (Gómez and Marval, 1996) and enters in natural logarithm, except current account balance, tax rates and interest rates.

Finally, we also control for a global factor, given by the real world GDP growth rate, which enters the model as an exogenous variable (Comunale, 2017). This helps us to weaken in part the presence of possible cross-section dependence. This concern is particularly salient in our setting, since in the period considered, the sample countries were hit by several common economic shocks.

Details of data sources, variables definition and descriptive statistics of key variables are provided in Appendix A.

5. Results

The analysis focuses on tax structure measured using alternatively both tax ratios and implicit tax rates and aims at evaluating the impact of a revenue-neutral tax shift on both, the real effective exchange rate (REER) and the terms of trade (TOT). In the empirical strategy, we rely on different homogeneity restrictions on the long run and short run parameters.

For a comparison with the existing literature, we start be estimating equation (1) controlling just for the variables that are often been considered as relative prices' determinants. To this end, we estimate three different specifications of the ECM. Results are shown in table 5.1.

[Insert table 5.1 here]

The Dynamic Fixed Effect (DFE) model constraints all coefficients, except intercept, to be equal across countries. The Pooled Mean Group (PMG) model allows for short run heterogeneous coefficients, whereas in the Mean Group (MG) all the coefficients are heterogeneous across countries.

In the first three columns of the table, we report the results for the analysis performed on the REER and in the last three we show the results when the TOT is taken as the dependent variable. Even if not directly comparable[5], the sign of the estimated coefficients are overall in line with those predicted by previous findings. The REER appreciates and the TOT depreciates after a long run productivity shock. The net foreign asset position (measured by the variable CAB) has the expected effects on the relative prices just in the short run, appreciating if a country has a current account surplus. A raise in government spending (G), as expected, leads to a devaluation of the TOT in the long run, whereas in the short run it hints to an opposite effect. The REER, instead, has not been influenced by this variable in the long run, but it depreciates after the shock occurs in the PMG estimates (column (2) of table 5.1).

We proceed in the analysis by adding the tax structure in the model. In table 5.2 we report the coefficients estimated using the DFE estimator under various model specifications. In columns (1)-(8), we show equation's (1) coefficients estimates for the REER and the TOT, respectively, when the variable of major interest for the aim of this paper, the tax-mix, is included as control. In columns (1), (3), (5) and (7) the tax wedge is computed using tax ratios (Tax-mix_{TR}) and in the remaining, we use implicit tax rates (Tax-mix_{ITR}).

[Insert table 5.2 here]

The estimated coefficients for the macroeconomic relative prices' determinants do not change significantly with respect to those shown in the previous table. As regard the tax variable, even if leading to an appreciation of the REER in the long run, it has no effect in the short run on this index. The TOT, instead, has not been affected by the fiscal shock neither in the long nor in the short run. A further novelty of our analysis is that, we do not look only at the contemporaneous impact of a shock in the tax-mix, but we also focus on the effect that may occur some periods after the shock (columns (3), (4), (7) and (8)). We assume that the effects of a fiscal policy may arise after a year, thus we insert in the regression four additional lags of the tax variable.[6] Results show that when the relative tax wedge is computed using implicit tax rates, the tax-mix has no impact on the REER once the shock occurs, while it appreciates two and four quarters after the shock (column (4)), in part corroborating with the theoretical prediction by Farhi et al. (2014). As regard the TOT, estimated coefficients in column (8) of table 5.2, give (a weak) support to the theoretical

[5] Existing studies do not distinguish between long run and short run responses.

[6] Estimates of the other coefficients do not significantly change if we consider a shorter lag length. Results are available upon request.

statement that the terms of trade should depreciate in the short after a shift from SSCs to VAT, if prices are setted under producer currency pricing.

Finally, the table shows that there is evidence of error correction since the convergence rate is negative and highly statistically significant in all the specifications.

Since the results may change when we assume that the effect of a shock in the tax-mix occurs after some quarters, we proceed in the analysis considering four additional lags of the tax variable.

Inference based on the DFE estimator may be highly uncertain since the homogeneity restrictions imposed may be sometimes invalid, especially in our sample. In what follows, we relax this restriction, first on the short run and then on both, the short run and the long run parameters.

We begin by estimating the Pooled Mean Group model (PMG) proposed by Pesaran et al. (1999), a model consistent under the assumption of long run slope homogeneity. This allows the short run coefficients, including the speed of convergence parameter φ_i, to be heterogeneous across panels, while the long run effects are homogeneous. Results are reported in columns (1)-(2) and (5)-(6) of table 5.3.

[Insert table 5.3 here]

First, what is worth noting is that the PMG model does not provide evidence for the presence of cointegration in all the specifications, the coefficient on the convergence rate in column (2) is in fact zero. This means that in this case, long run coefficients estimates are not reliable. When we use tax ratios, instead (column (1)), the convergence rate gives support to the presence of a cointegrating relationship. The long run coefficient on the tax-mix is negative and highly statistically significant and shows that the REER depreciates in the long run, while in the short run it appreciates. The impact of the tax-mix on the TOT is negative and significant in the short run when we use either tax ratios or implicit tax rates (columns (5) and (6)).

However, as pointed out by Xing (2012) the homogeneity restriction imposed by the PMG is invalid for some of the long run coefficients, thus estimates based on this model may be sometimes biased. To test the validity of this restriction we run the alternative Wald test suggested by Xing (2012). Results are reported in table 5.4 for both, tax ratios (Panel A) and implicit tax rates (Panel B) and the findings are quite robust in both panels.

[Insert table 5.4 here]

Results from the Wald test suggest that we cannot rely on the long run homogeneity restriction for most of the coefficients and for all variables jointly in all the specifications reported in the table. We thus compare the results from the PMG with those obtained with an estimator assuming that both, the short run and the long run coefficients are heterogeneous across countries.

We run the Mean Group (MG) estimator, which yields country-specific long run coefficients that are then averaged across the panel. However, one potential drawback of this methodology is that it may be sensitive to the possible presence of country-specific estimates with extreme values. The outlier-robust variant of the MG estimator (Bond et al., 2010) addresses this issue by putting smaller weights on country-specific estimates with extreme values relative to the sample distribution.[7]

In columns (3)-(4) and (7)-(8) of table 5.3, we summarize the results from the MG. Now, in all the specifications estimated, the speed of convergence parameter provides significant evidence of the presence of a long run equilibrium relationship. As regards the coefficients estimated on the tax-mix, they point to a short run appreciation of the CPI deflated REER some quarters after the shock. The result holds if we use either tax ratios or implicit tax rates. No significant effects, instead, arise on the TOT, neither in the long nor in the short run.

In order to explicitly analyse the heterogeneous responses across countries, we further perform a time series analysis for each cross-section unit separately, running an autoregressive distributed lag model (ARDL). From the table B.1 to B.4 of Appendix B we show the results for the long run and short run coefficients estimated on the tax-mix (computed using tax ratios in the tables B.1 and B.3 and implicit tax rates in the tables B.2 and B.4) and the speed of convergence parameter.

Finally, we conclude the analysis by taking into account the presence of unobserved common factors. Table 5.5 reports the results from the Pesaran (2006) CCE estimations.

[Insert table 5.5 here]

We adopt the standard CCE estimator in the mean group version (CMG), employing robust regression in the computation of the coefficients averages. However, the CCE approach has sometimes been shown to be invalid if the model includes a lagged dependent variable. Thus,

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[7] Results from the outlier-robust variant of the MG estimator are very similar to those achieved with the unweighetd MG, thus, for expositional purposes we do not report the estimated coefficients. Results are available upon request.

following the suggestion of Chudik and Pesaran (2015) we adjust the model by including in the specification some additional lags of the cross-section averages of the dependent and the control variables. The results, despite showing a further better control for the cross-sectional dependence (at least in the regression for the REER), do not provide different coefficient estimates, thus for expositional purposes we do not report the results[8].

Estimated coefficients for the tax shift in table 5.5 highlight that some significant effects on relative prices arise when the tax structure is measured using tax ratios. In particular, the REER experiences a short run depreciation, whereas the effect reverses into an appreciation in the long run. These results, however, are in contrast with the theory, which suggests that irrespective of the price setting environment considered, a fiscal devaluation should lead to a short run real effective exchange rate appreciation. As regard the TOT, the coefficients reported in column (3) of table 5.5 weakly corroborate with the theoretical prediction of a short run TOT depreciation, under the assumption of producer currency pricing setting.

In all the tables we report the Pesaran (2004) CD test for cross-section independence in macro panel data. In the DFE, PMG and MG models, the CD statistics highlight the presence of residual cross-sectional dependence. The statistic drops significantly when we shift to the CMG, confirming that the use of cross-section averages considerably reduces the cross-sectional dependence.

As a robustness checks, we first follow the suggestion by Farhi et al. (2014) which stated that a fiscal devaluation, in order to replicate the behaviour of the REER under a nominal depreciation, should be associated with a consumption subsidy and a labour income tax. We therefore run the estimations including the latter two fiscal instruments as further controls and the results do not significantly change. Moreover, since each estimation contains a dummy for the economic crisis, we also run our analyses considering country-specific crisis dummies, and the results remain unchanged also in this specification.[9]

Concluding, our results show that the estimated coefficients on the relative prices' determinants are overall in line with those predicted by previous works, even if not directly comparable.

[8] Results are available upon request.

[9] Results from the robustness checks are available upon request.

However, the effects almost entirely vanish when we run our preferred model specification, in which we allow for heterogeneous coefficients estimates also accounting for the cross-sectional dependence.

As regards the policy variable, our findings do not provide strong support to the claim that the tax structure may be a significant determinant for the relative prices studied. We find that the effects are highly heterogeneous across countries, as one would expect given the sample analysed. When tax ratios are used as indicator for the tax structure, our results support the theoretical predictions about the expected effects of a fiscal devaluation on the TOT, but not on the REER. Both relative prices experience a devaluation in the short run after a shock in the tax-mix when both, heterogeneity and cross-sectional dependence are accounted for.

6. Conclusions

Differences in taxation structures are of particular relevance, especially for euro area countries, which share a fixed nominal exchange rate. This feature makes it elusive to affect the competitiveness of economies through nominal exchange rate adjustments. This issue has been in the last years, at the heart of government debates on whether those euro area countries, which need to improve their internal competitiveness, may mimic the effects of the devaluation of the exchange rate through an appropriate use of fiscal instruments, in particular, by rebalancing the tax structure away from direct taxes towards indirect taxes.

The theory suggests that a fiscal devaluation should have, at least in the short run, a positive impact on a country's market share by making its exports more competitive with respect to those of the trading partners. On this concern, rely most of the analyses on the effects of a fiscal devaluation.

We have investigated this issue by looking at the direct effect of the tax shift on the two main international relative prices – the consumer price real effective exchange rate and the terms of trade.

The work by Farhi et al. (2014) has clarified that under some conditions an increase in the VAT and the introduction of a payroll subsidy should mimic the behaviour of the two relative prices in the context of a nominal devaluation, even in a currency union where the exchange rate cannot be devalued. The use of VAT and payroll tax suffices to replicate the behaviour of the TOT, which depreciate if prices are setted under producer currency. The REER requires in addition the introduction of a consumption subsidy and a labour income tax, otherwise fiscal devaluations result in an appreciated REER relative to a nominal devaluation. Overall, our results are in line with theoretical predictions for the TOT, but not for the REER. Both the relative prices, in fact, depreciate in the short run when we estimate our preferred model specification, if the relative tax wedge is computed using tax ratios. A devaluation of relative prices, on the other hand, may lead to an improvement in the country's trade balance Thus our analysis provides an indirect (weak) empirical evidence in support to the claim that a fiscal devaluation may improve a country's internal competitiveness by means of movement in relative prices.

Future works should investigate if the results are valid even under different model settings. Since the VAT is not the only instrument by which a SSCs reduction may be financed, a range of alternative forms of fiscal devaluation could be investigated. The study on the effects of fiscal shocks should also consider the possible presence of non-linearity in the data. Finally, another possible extension of this work could be to investigate if the effects of a tax shift are driven by some spillover mechanisms among the member countries.

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Table 3.1. Panel Unit Root Tests

Variables	Im, Pesaran and Shin (2003) W-t-bar		Maddala-Wu (1999) Chi-sq		Pesaran CIPS (2007) Zt-bar	
	Level	First diff.	Level	First diff.	Level	First diff.
REER	0.994	0.000	0.962	0.000	0.728	0.000
TOT	0.752	0.000	0.753	0.000	0.689	0.000
Y	0.034	0.000	0.098	0.000	0.952	0.000
I	0.988	0.000	1.000	0.000	0.606	0.000
CAB	0.098	0.000	0.259	0.000	0.528	0.000
G	0.372	0.000	0.415	0.000	0.919	0.000
T	0.578	0.000	0.835	0.000	0.975	0.000
Tax-mix$_{TR}$	0.158	0.000	0.100	0.000	0.104	0.000
Tax-mix$_{ITR}$	0.234	0.000	0.309	0.000	0.343	0.000

Notes: The numbers represent p-values for the unit root tests. Tax rates variables are measured as a deviation from the rest of EA country. REER, TOT, Y, G and T are expressed in natural logs. The null for IPS (2003) is that all panels contain unit roots. MW (1999) and CIPS (2007) test the null hypothesis that series are integrated of order 1. MW assumes cross-section independence; CIPS test, assumes cross-section dependence in the form of a single unobserved common factor. All the tests include 4 lags and a trend. The 14 countries included in the data set are Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Luxembourg, Netherlands, Portugal, Slovakia and Spain. The observation period is 2002Q1-2016Q4.

Table 5.1. Relative prices' determinants

Dep. Variable	REER			TOT		
	DFE (1)	PMG (2)	MG (3)	DFE (4)	PMG (5)	MG (6)
Long Run						
Y	0.546	0.562***	0.2871	-0.153	-0.280***	0.1363
	(0.483)	(0.070)	(2.334)	(0.113)	(0.038)	(0.314)
I	0.001	-0.0042**	-0.0267	-0.002	-0.0047***	-0.0031
	(0.008)	(0.002)	(0.026)	(0.002)	(0.001)	(0.005)
CAB	-0.012***	-0.0082***	-0.0037	-0.001	0.00003	0.0026
	(0.003)	(0.002)	(0.010)	(0.001)	(0.0000)	(0.002)
G	-0.053	0.0832	-0.3991	-0.198***	-0.2439***	-0.1238
	(0.241)	(0.081)	(0.762)	(0.056)	(0.036)	(0.135)
Short Run						
ΔY	-0.069***	-0.0453**	-0.0148	0.042	-0.196	0.0459
	(0.022)	(0.021)	(0.019)	(0.060)	(0.078)	(0.096)
ΔI	0.0003	-0.0002	-0.00006	0.0001	-0.0026***	-0.0018
	(0.0002)	(0.0000)	(0.0000)	(0.001)	(0.001)	(0.001)
ΔCAB	0.0004***	0.0002**	0.00009	0.001***	0.0015***	0.0010
	(0.0001)	(0.0000)	(0.0000)	(0.0001)	(0.001)	(0.001)
ΔG	-0.007	-0.0173***	-0.0127	0.026	0.0904**	0.0847*
	(0.007)	(0.006)	(0.008)	(0.024)	(0.044)	(0.048)
Convergence Rate	**-0.043*** (0.013)**	**-0.0342*** (0.013)**	**-0.0847*** (0.022)**	**-0.153*** (0.028)**	**-0.1877*** (0.033)**	**-0.3590*** (0.054)**
CD	**10.18**	**15.87**	**44.84**	**23.76**	**30.81**	**26.23**
Obs.	**814**	**814**	**814**	**814**	**814**	**814**

Notes: results for a sample of 14 countries covering the period 2002Q1-2016Q4 based on the estimators defined in the second row. Each estimation contains a dummy variable for the economic crisis and an exogenous global factor (the real world GDP growth rate). The dependent variable is the first difference of the variable defined in the first row. CD reports the Pesaran (2004) test for cross-section dependence based on the residuals. *** p<0.01, ** p<0.05, * p<0.1. Standard errors in parenthesis.

Table 5.2. DFE estimations under different model specifications

Dep. Variable	REER				TOT			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Long Run								
Y	0.513***	0.544**	0.274*	0.250	-0.160	-0.161	-0.204**	-0.187*
	(0.172)	(0.215)	(0.164)	(0.186)	(0.103)	(0.105)	(0.097)	(0.101)
I	0.005	0.005	0.003	0.003	-0.002	-0.002	-0.002	-0.003
	(0.006)	(0.006)	(0.005)	(0.005)	(0.002)	(0.002)	(0.002)	(0.002)
CAB	-0.008***	-0.007***	-0.007***	-0.007***	-0.001	-0.001	-0.001	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
G	-0.008	-0.020	-0.043	-0.042	-0.208***	-0.213***	-0.214***	-0.222***
	(0.168)	(0.179)	(0.136)	(0.150)	(0.045)	(0.046)	(0.039)	(0.039)
T	0.077	0.054	0.099*	0.100	0.011	0.010	0.001	-0.005
	(0.055)	(0.058)	(0.059)	(0.062)	(0.024)	(0.025)	(0.027)	(0.028)
Tax-mix$_{TR}$	0.138***		0.088***		0.019		0.009	
	(0.018)		(0.019)		(0.013)		(0.013)	
Tax-mix$_{ITR}$		0.126***		0.071***		0.014		0.011
		(0.018)		(0.020)		(0.011)		(0.012)
Short Run								
ΔY	-0.055***	-0.059***	-0.052***	-0.052***	0.063	0.061	0.068	0.065
	(0.011)	(0.013)	(0.012)	(0.013)	(0.063)	(0.063)	(0.063)	(0.062)
ΔI	0.0000	-0.0000	0.0002	0.0001	-0.0000	-0.0000	0.0002	0.0001
	(0.0004)	(0.0005)	(0.0003)	(0.0004)	(0.001)	(0.001)	(0.001)	(0.001)
ΔCAB	0.0004***	0.0004***	0.0004***	0.0004***	0.001***	0.001***	0.001***	0.001***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
ΔG	-0.009	-0.009	-0.009*	-0.008*	0.028	0.029	0.028	0.029
	(0.006)	(0.006)	(0.005)	(0.004)	(0.024)	(0.024)	(0.025)	(0.024)
ΔT	0.004	0.005	0.004	0.004	-0.025	-0.024	-0.025	-0.022
	(0.007)	(0.007)	(0.006)	(0.007)	(0.024)	(0.024)	(0.023)	(0.022)
ΔTax-mix$_{TR}$	-0.008		-0.007		-0.008		-0.012	
	(0.005)		(0.006)		(0.008)		(0.009)	
Lag 1			-0.004				-0.008	
			(0.005)				(0.007)	
Lag 2			0.002				-0.012	
			(0.003)				(0.009)	
Lag 3			-0.003				-0.004	
			(0.003)				(0.006)	
Lag 4			0.002				0.0001	
			(0.002)				(0.006)	
ΔTax-mix$_{ITR}$		-0.007		-0.050		-0.010		-0.016*
		(0.005)		(0.005)		(0.008)		(0.010)
Lag 1				0.0001				-0.012*
				(0.002)				(0.007)
Lag 2				0.07***				-0.016**
				(0.002)				(0.008)
Lag 3				0.002				-0.004
				(0.002)				(0.006)
Lag 4				0.005***				-0.0001
				(0.002)				(0.006)
Convergence Rate	**-0.058*****	**-0.059*****	**-0.059*****	**-0.058*****	**-0.157*****	**-0.157*****	**-0.185*****	**-0.184*****
	(0.010)	**(0.012)**	**(0.008)**	**(0.007)**	**(0.029)**	**(0.030)**	**(0.036)**	**(0.037)**
CD	**21.31**	**21.45**	**21.74**	**21.94**	**22.13**	**22.84**	**24.31**	**25.81**
Obs.	**814**	**814**	**758**	**758**	**814**	**814**	**758**	**758**

Notes: results for a sample of 14 countries covering the period 2002Q1-2016Q4 based on the DFE estimator. Each estimation contains a dummy variable for the economic crisis and an exogenous global factor (the real world GDP growth rate). The dependent variable is the first difference of the variable defined in the first row. CD reports the Pesaran (2004) test for cross-section dependence based on the residuals. *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parenthesis.

Table 5.3. PMG and MG estimations under different model specifications

Dep. Variable	REER				TOT			
	PMG (1)	PMG (2)	MG (3)	MG (4)	PMG (5)	PMG (6)	MG (7)	MG (8)
Long Run								
Y	0.172***	4.652	-0.096	-0.171	-0.128**	-0.343***	-0.464**	-0.614***
	(0.061)	(13.438)	(0.231)	(0.187)	(0.063)	(0.079)	(0.213)	(0.226)
I	-0.005***	-0.140	0.001	0.003	-0.003***	-0.005***	-0.001	0.001
	(0.002)	(0.410)	(0.002)	(0.002)	(0.001)	(0.001)	(0.004)	(0.004)
CAB	-0.003**	0.065	0.001	0.001	-0.001*	-0.0001	0.005	0.004
	(0.001)	(0.187)	(0.002)	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)
G	0.112**	5.898	0.105	0.067	-0.199***	-0.268***	0.014	0.004
	(0.056)	(17.009)	(0.091)	(0.081)	(0.037)	(0.047)	(0.132)	(0.131)
T	0.158***	2.176	0.056	0.079**	0.021	-0.003	0.087	0.101
	(0.022)	(6.069)	(0.045)	(0.039)	(0.017)	(0.022)	(0.088)	(0.119)
Tax-mix_{TR}	-0.201***		-0.092		0.027**		-0.0001	
	(0.048)		(0.091)		(0.011)		(0.117)	
Tax-mix_{ITR}		1.803		0.039		-0.009		-0.030
		(5.268)		(0.108)		(0.016)		(0.125)
Short Run								
ΔY	-0.053**	-0.028	-0.035	-0.030	0.027	0.056	0.121	0.124
	(0.024)	(0.022)	(0.024)	(0.022)	(0.084)	(0.073)	(0.100)	(0.086)
ΔI	0.0001	0.001**	-0.0001	-0.0003	-0.003**	-0.003**	-0.004**	-0.004***
	(0.0001)	(0.0001)	(0.0001)	(0.000)	(0.001)	(0.001)	(0.002)	(0.002)
ΔCAB	0.0001	0.0001	-0.0001	-0.0001	0.001***	0.001***	-0.0001	0.0001
	(0.0001)	(0.000)	(0.0001)	(0.000)	(0.0001)	(0.0001)	(0.001)	(0.001)
ΔG	-0.014	-0.006	-0.006	-0.005	0.138**	0.126**	0.086	0.086
	(0.009)	(0.012)	(0.010)	(0.010)	(0.064)	(0.060)	(0.068)	(0.063)
ΔT	-0.014	-0.002	-0.017	-0.017	-0.010	-0.013	0.013	0.003
	(0.016)	(0.008)	(0.014)	(0.012)	(0.022)	(0.022)	(0.043)	(0.033)
$\Delta\text{Tax-mix}_{TR}$	0.009***		0.006		-0.018*		-0.049	
	(0.003)		(0.006)		(0.010)		(0.039)	
Lag 1	0.008***		0.007		-0.011		-0.037	
	(0.002)		(0.006)		(0.010)		(0.032)	
Lag 2	0.011***		0.011**		-0.015		-0.037	
	(0.003)		(0.005)		(0.013)		(0.024)	
Lag 3	0.005**		0.005*		-0.001		-0.020	
	(0.002)		(0.003)		(0.006)		(0.020)	
Lag 4	0.006**		0.006***		-0.001		-0.011	
	(0.002)		(0.002)		(0.012)		(0.015)	
$\Delta\text{Tax-mix}_{ITR}$		0.002		0.001		-0.028**		-0.030
		(0.004)		(0.008)		(0.013)		(0.042)
Lag 1		0.003*		0.004		-0.017		-0.021
		(0.002)		(0.007)		(0.012)		(0.035)
Lag 2		0.010***		0.011*		-0.013		-0.023
		(0.004)		(0.006)		(0.014)		(0.027)
Lag 3		0.004		0.006		0.0001		-0.013
		(0.003)		(0.005)		(0.007)		(0.023)
Lag 4		0.005*		0.008***		-0.010		-0.018
		(0.003)		(0.003)		(0.010)		(0.016)
Convergence Rate	**-0.046****	**-0.0001**	**-0.183*****	**-0.180*****	**-0.201*****	**-0.163*****	**-0.457*****	**-0.434*****
	(0.022)	**(0.001)**	**(0.033)**	**(0.031)**	**(0.046)**	**(0.030)**	**(0.050)**	**(0.048)**
CD	**34.68**	**33.3**	**23.92**	**21.60**	**20.89**	**26.84**	**7.59**	**6.11**
Obs.	**758**	**758**	**758**	**758**	**758**	**758**	**758**	**758**

Notes: results for a sample of 14 countries covering the period 2002Q1-2016Q4 based on the estimation approach identified in the second row. Each estimation contains a dummy variable for the economic crisis and an exogenous global factor (the real world GDP growth rate). The dependent variable is the first difference of the variable defined in the first row. CD reports the Pesaran (2004) test for cross-section dependence based on the residuals. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Standard errors in parenthesis.

Table 5.4. Modified Wald Test of equal long run coefficients across countries

Panel A		
Dep. Variable	**REER (1)**	**TOT (2)**
Y	0.000	0.000
I	0.023	0.099
CAB	0.151	0.000
G	0.155	0.000
T	0.000	0.000
Tax-mix$_{TR}$	0.000	0.000
Join Test	0.000	0.001

Panel B		
Dep. Variable	**REER (1)**	**TOT (2)**
Y	0.001	0.000
I	0.000	0.000
CAB	0.165	0.000
G	0.000	0.000
T	0.000	0.000
Tax-mix$_{ITR}$	0.033	0.051
Join Test	0.001	0.000

Notes: results from the modified Wald test examining the validity of common long run coefficients restriction imposed in the PMG estimations. Panel A in columns (1) and (2) shows the results of the Wald test for the coefficients presented respectively in columns (1) and (5) of table 5.3, which include as dependent variable respectively the first difference of the REER and of the TOT and as fiscal control the relative tax mix computed using the tax ratios (Tax-mix$_{TR}$**).** Panel B in columns (1) and (2) shows the results of the Wald test for the coefficients presented respectively in columns (2) and (6) of table 5.3, which include as dependent variable respectively the first difference of the REER and of the TOT and as fiscal control the relative tax mix computed using implicit tax rates(Tax-mix$_{ITR}$).

Table 5.5. CMG estimations under different model specifications

Dep. Variable	REER		TOT	
	(1)	(2)	(3)	(4)
Long Run				
Y	-0.111	-0.015	-0.043	-0.015
	(0.127)	(0.113)	(0.158)	(0.136)
I	0.003	0.001	0.004**	0.004**
	(0.002)	(0.001)	(0.002)	(0.001)
CAB	0.0004**	0.001*	-0.0001	-0.0001
	(0.000)	(0.001)	(0.001)	(0.001)
G	0.001	-0.0016	0.025	0.007
	(0.032)	(0.047)	(0.040)	(0.032)
T	0.015	0.018	0.007	-0.008
	(0.035)	(0.038)	(0.039)	(0.030)
Tax-mix$_{TR}$	0.057***		-0.003	
	(0.015)		(0.038)	
Tax-mix$_{ITR}$		0.030		-0.042
		(0.031)		(0.050)
Short Run				
ΔY	-0.046	-0.048	0.062	0.032
	(0.040)	(0.028)	(0.110)	(0.101)
ΔI	-0.000	-0.0001	-0.004**	-0.004**
	(0.001)	(0.001)	(0.002)	(0.001)
ΔCAB	-0.0001	-0.0001	-0.0001	0.0001
	(0.0001)	(0.0001)	(0.001)	(0.001)
ΔG	-0.010	-0.004	0.027	0.018
	(0.011)	(0.009)	(0.027)	(0.025)
ΔT	-0.001	-0.015	-0.0001	0.006
	(0.012)	(0.013)	(0.021)	(0.023)
ΔTax-mix$_{TR}$	-0.024***		-0.011	
	(0.008)		(0.028)	
Lag 1	-0.016		-0.032	
	(0.009)		(0.025)	
Lag 2	-0.016		-0.032	
	(0.009)		(0.025)	
Lag 3	-0.004		-0.042*	
	(0.008)		(0.023)	
Lag 4	-0.007		-0.019	
	(0.007)		(0.017)	
ΔTax-mix$_{ITR}$		-0.011		0.009
		(0.010)		(0.039)
Lag 1		-0.009		-0.003
		(0.005)		(0.026)
Lag 2		-0.009		-0.003
		(0.005)		(0.026)
Lag 3		0.001		-0.021
		(0.006)		(0.023)
Lag 4		0.001		-0.0003
		(0.008)		(0.016)
Convergence Rate	**-0.436*** **	**-0.419*** **	**-0.867*** **	**-0.878*** **
	(0.073)	**(0.066)**	**(0.061)**	**(0.071)**
CD	**-2.07**	**-2.20**	**-1.87**	**-1.31**
Obs.	**758**	**758**	**758**	**758**

Notes: results for a sample of 14 countries covering the period 2002Q1-2016Q4 based on the CCE estimator in the mean group version (CMG). Each estimation contains a dummy variable for the economic crisis and an exogenous global factor (the real world GDP growth rate). The dependent variable is the first difference of the variable defined in the first row. CD reports the Pesaran (2004) test for cross-section dependence based on the residuals. *** p<0.01, ** p<0.05, * p<0.1. Standard errors in parenthesis.

Appendix A: Definition and sources of variables

The variables used in the regression are defined as follows:

- CPI deflated Real Effective Exchange Rate (REER) (index, 2010=100); an increase in this indicator means a real appreciation. Source: European Commission, Price and Cost Competitiveness database.
- Terms of Trade (TOT) (index, 2010=100); computed as the ratio of exports prices to imports prices. An increase in this indicator means an appreciation. Source: authors' calculations based on OECD Quarterly National Accounts data.
- Labour productivity per person (Y) (index, 2010=100) is given by GDP (chain-linked volumes reference year 2010) over total employment (all industries, in persons). Source: Eurostat.
- Current account balance (CAB) (as a percentage of GDP); is the difference between current receipts from abroad and current payments to abroad. Source: OECD, Balance of Payments (MEI).
- Government spending (G) (as a percentage of GDP), computed as the sum of government consumption and government investment. Source: Eurostat, quarterly non-financial accounts for general government.
- Total revenues (T) (as a percentage of GDP). Source: Eurostat, quarterly non-financial accounts for general government.
- Long-term interest rate (I) (percent per annum). Source: OECD Monthly Monetary and Financial Statistics.
- Tax-mix using implicit tax rates ($\text{Tax-mix}_{\text{ITR}}$) computed as the ratio between VAT vs SSC tax wedges ($\text{ITR}_{\text{vat}}/\text{ITR}_{\text{ssc}}$) for country *i* and the geometric weighted average of relative tax wedges in trading partners *j* ($j \neq i$), as follows:

$$\text{Tax-mix}_{\text{ITR}} = \frac{\text{ITR}_{\text{vat,i}}/\text{ITR}_{\text{ssc,i}}}{\prod_{j \neq i} (\text{ITR}_{\text{vat,j}}/\text{ITR}_{\text{ssc,j}})^{\text{w}_{\text{j,t}}}},$$

where $\text{w}_{\text{j,t}}$, represent the time-varying trade weights.

Implicit tax rates are computed as follows:

$$ITR_{vat}=\frac{d211,rec}{p31\_s14}$$

- d211,rec: VAT, receivable;
- p31_s14: Final consumption expenditure of households.

$$ITR_{ssc}=\frac{d611+d613}{coel+WSE}$$

- d611 Employers' actual social contributions;
- d613 Households' actual social contributions;
- coel: Compensation of employees;
- WSE represents the wage bill, computed as follows:

$$WSE=\frac{ES*W}{EE},$$

ES and EE are, respectively, self-employment and dependent employment (thousands of persons). W represents wages and salaries.

- In a similar manner, we compute the tax mix using tax ratios (Tax-mix$_{TR}$). Tax ratios are obtained by dividing tax revenues on VAT and SSCs, respectively, by total revenues.

Tax revenues data (in million units of national currencies) comes from Eurostat, Quarterly non-financial accounts for general governments (data on SSCs for Italy comes from Istat). National accounts data (in million units of national currencies) from Eurostat, Quarterly National Accounts database.

- The real world GDP growth rate is taken from the International Financial Statistics (IFS) database.

All variables are seasonally adjusted using the TRAMO/SEATS methodology (Gómez and Marval, 1996).

Table A1. Descriptive statistics

Variables	Description	Obs.	Mean	Std. Dev.	Min	Max
REER	Log of CPI deflated REER	840	4.591	0.065	4.098	4.661
TOT	Log of the Terms of Trade	840	4.610	0.031	4.532	4.756
Y	Log of Productivity	840	4.596	0.074	4.226	4.959
I	Long-term interest rate	829	3.924	2.554	-0.376	24.979
CAB	Current Account Balance	840	-0.267	6.183	-25.113	12.864
G	Log of Gov. Spending	840	3.149	0.125	2.594	3.435
T	Log of Total Revenues	840	10.322	1.502	6.492	12.794
Tax-mix$_{TR}$	Tax mix using tax ratios (TR_{vat}/TR_{ssc})	840	1.278	0.592	0.468	3.942
Tax-mix$_{ITR}$	Tax mix using implicit tax rates (ITR_{vat}/ITR_{ssc})	840	1.271	0.632	0.489	4.122

Notes: The 14 countries included in the data set are: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Luxembourg, Netherlands, Portugal, Slovakia and Spain. The observation period is 2002Q1-2016Q4. There is a break in the data for long-term interest rates for Luxemburg in the period 2007Q3-2010Q1.

Appendix B: Cross-country estimates

Table B.1. – Cross-country estimates, fiscal variable computed using tax ratios

Dep. Variable			**REER**				
Tax-mix$_{TR}$							
	Convergence rate	**Long run**	**Δ**	**Lag 1**	**Lag 2**	**Lag 3**	**Lag 4**
Austria	**-0.184***	-0.022	0.022	0.036	0.036	0.027	0.003
	(0.097)	(0.028)	(0.029)	(0.026)	(0.022)	(0.017)	(0.013)
Belgium	**-0.078**	-0.081***	0.062**	0.060**	0.048**	0.029*	0.012
	(0.092)	(0.027)	(0.027)	(0.023)	(0.021)	(0.016)	(0.013)
Finland	**-0.094*****	-0.012	0.030	0.018	0.008	0.002	-0.002
	(0.074)	(0.016)	(0.018)	(0.016)	(0.016)	(0.012)	(0.009)
France	**-0.405*****	0.044*	-0.007	-0.015	-0.005	-0.005	0.008
	(0.135)	(0.023)	(0.021)	(0.018)	(0.016)	(0.015)	(0.012)
Germany	**-0.190****	-0.020**	0.024**	0.029***	0.026**	0.009	0.001
	(0.072)	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)	(0.008)
Greece	**-0.066**	0.019	-0.014	-0.021	-0.019	-0.013	-0.001
	(0.067)	(0.029)	(0.027)	(0.024)	(0.019)	(0.015)	(0.010)
Ireland	**-0.236*****	0.015***	-0.013***	-0.004	-0.004	-0.001	-0.001
	(0.070)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.010)
Italy	**-0.077**	0.024	-0.003	-0.000	0.005	-0.003	-0.001
	(0.114)	(0.016)	(0.015)	(0.013)	(0.013)	(0.011)	(0.002)
Latvia	**0.244***	-0.027	-0.006	-0.006	0.009	0.008	0.005
	(0.126)	(0.047)	(0.042)	(0.035)	(0.030)	(0.025)	(0.008)
Luxembourg	**-0.041**	-0.010	0.008	0.008	0.014*	0.008	0.027***
	(0.080)	(0.007)	(0.008)	(0.008)	(0.007)	(0.007)	(0.008)
Netherlands	**-0.213****	0.008	0.000	0.002	0.009	0.005	0.007
	(0.103)	(0.017)	(0.014)	(0.011)	(0.010)	(0.009)	(0.006)
Portugal	**-0.401*****	0.017	-0.010	-0.008	-0.007	-0.010	0.002
	(0.126)	(0.013)	(0.012)	(0.009)	(0.009)	(0.007)	(0.005)
Slovakia	**-0.272*****	0.019	-0.018	-0.002	0.013	0.013	0.013
	(0.062)	(0.020)	(0.019)	(0.018)	(0.016)	(0.014)	(0.010)
Spain	**-0.054**	-0.025**	0.013	0.006	0.016**	0.008	0.005
	(0.083)	(0.012)	(0.010)	(0.008)	(0.008)	(0.007)	(0.006)

Notes: results for a time series analysis covering the period 2002Q1-2016Q4 based on an error correction model (ARDL). Each estimation contains a dummy variable for the economic crisis and an exogenous global factor (the real world GDP growth rate). *** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses.

Table B.2. – Cross-country estimates, fiscal variable computed using implicit tax rates

Dep. Variable			**REER**				
Tax-mix$_{ITR}$							
	Convergence rate	**Long run**	**Δ**	**Lag 1**	**Lag 2**	**Lag 3**	**Lag 4**
Austria	**-0.132**	-0.010	0.009	0.023	0.034	0.022	0.003
	(0.084)	(0.026)	(0.027)	(0.024)	(0.021)	(0.017)	(0.013)
Belgium	**-0.175**	-0.068***	0.057**	0.051**	0.043**	0.023	0.011
	(0.104)	(0.022)	(0.023)	(0.022)	(0.020)	(0.015)	(0.011)
Finland	**-0.0136***	-0.013	0.028	0.018	0.012	0.005	-0.001
	(0.078)	(0.016)	(0.020)	(0.018)	(0.017)	(0.012)	(0.008)
France	**-0.410*** **	0.033	0.001	-0.013	-0.001	-0.000	0.012
	(0.131)	(0.020)	(0.019)	(0.016)	(0.015)	(0.014)	(0.012)
Germany	**-0.163** **	-0.022**	0.025**	0.029***	0.025**	0.009	-0.001
	(0.061)	(0.009)	(0.010)	(0.011)	(0.011)	(0.010)	(0.008)
Greece	**-0.071**	0.093***	-0.071***	-0.063***	-0.048***	-0.032**	-0.007
	(0.042)	(0.025)	(0.023)	(0.019)	(0.017)	(0.014)	(0.010)
Ireland	**-0.124**	0.009	-0.006	0.001	0.001	0.002	0.002
	(0.086)	(0.005)	(0.005)	(0.005)	(0.004)	(0.003)	(0.002)
Italy	**-0.082**	0.018	0.008	0.007	0.013	-0.005	0.011
	(0.124)	(0.021)	(0.019)	(0.016)	(0.016)	(0.014)	(0.011)
Latvia	**-0.234** **	-0.011	-0.020	0.004	0.039	0.043*	0.031
	(0.105)	(0.023)	(0.027)	(0.026)	(0.026)	(0.025)	(0.021)
Luxembourg	**-0.048**	-0.008	0.006	0.006	0.009*	0.005	0.016***
	(0.091)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)
Netherlands	**-0.204***	0.002	0.004	0.004	0.009	0.004	0.006
	(0.104)	(0.015)	(0.012)	(0.010)	(0.009)	(0.007)	(0.005)
Portugal	**-0.403*** **	0.012	-0.005	-0.005	-0.006	-0.012	0.002
	(0.125)	(0.012)	(0.012)	(0.010)	(0.009)	(0.007)	(0.006)
Slovakia	**-0.267*** **	0.027	-0.031	-0.011	0.009	0.012	0.014
	(0.061)	(0.029)	(0.028)	(0.026)	(0.023)	(0.020)	(0.015)
Spain	**-0.076**	-0.027**	0.014	0.007	0.017**	0.008	0.006
	(0.078)	(0.012)	(0.010)	(0.009)	(0.008)	(0.007)	(0.006)

Notes: results for a time series analysis covering the period 2002Q1-2016Q4 based on an error correction model (ARDL). Each estimation contains a dummy variable for the economic crisis and an exogenous global factor (the real world GDP growth rate). *** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses.

Table B.3. – Cross-country estimates, fiscal variable computed using tax ratios

Dep. Variable	TOT						
Tax-mix$_{TR}$							
	Convergence rate	**Long run**	**Δ**	**Lag 1**	**Lag 2**	**Lag 3**	**Lag 4**
Austria	**-0.194****	-0.107	0.024	0.023	-0.027	-0.034	-0.052
	(0.081)	(0.074)	(0.078)	(0.071)	(0.062)	(0.050)	(0.037)
Belgium	**-0.369****	-0.071	0.043	0.048	0.049	0.042	0.014
	(0.139)	(0.084)	(0.079)	(0.069)	(0.061)	(0.050)	(0.040)
Finland	**-0.580*****	-0.039	0.058	-0.004	-0.029	0.068	0.150**
	(0.181)	(0.134)	(0.148)	(0.125)	(0.117)	(0.090)	(0.070)
France	**-0.236*****	-0.143	-0.026	0.013	0.009	0.057	-0.041
	(0.079)	(0.101)	(0.091)	(0.079)	(0.079)	(0.073)	(0.060)
Germany	**-0.104**	-0.050	0.096**	0.123***	0.062	0.022	0.007
	(0.069)	(0.034)	(0.035)	(0.040)	(0.040)	(0.037)	(0.031)
Greece	**-0.596*****	0.380**	-0.278*	-0.193	-0.168	-0.152*	-0.057
	(0.144)	(0.146)	(0.137)	(0.123)	(0.101)	(0.081)	(0.053)
Ireland	**-0.638*****	0.032**	-0.012	-0.019	-0.020	-0.006	-0.017
	(0.144)	(0.014)	(0.022)	(0.023)	(0.023)	(0.021)	(0.020)
Italy	**0.388*****	0.422***	-0.455***	-0.380***	-0.283***	-0.210***	-0.119**
	(0.084)	(0.091)	(0.087)	(0.077)	(0.080)	(0.064)	(0.051)
Latvia	**-0.599*****	0.003	-0.033	-0.037	0.008	-0.006	-0.016
	(0.131)	(0.044)	(0.042)	(0.038)	(0.034)	(0.030)	(0.025)
Luxembourg	**-0.463*****	-0.036	0.0001	-0.043	-0.077**	-0.013	-0.009
	(0.187)	(0.035)	(0.041)	(0.041)	(0.036)	(0.035)	(0.037)
Netherlands	**-0.606*****	0.126*	-0.087	-0.061	-0.045	-0.031	-0.008
	(0.182)	(0.068)	(0.053)	(0.040)	(0.032)	(0.024)	(0.017)
Portugal	**-0.446*****	-0.074	0.018	0.030	0.023	-0.010	-0.008
	(0.124)	(0.055)	(0.047)	(0.036)	(0.030)	(0.022)	(0.017)
Slovakia	**-0.423****	0.031	-0.018	-0.007	-0.003	0.006	-0.001
	(0.187)	(0.030)	(0.030)	(0.029)	(0.025)	(0.022)	(0.014)
Spain	**-0.456*****	0.079	-0.013	-0.015	-0.012	-0.008	-0.003
	(0.158)	(0.061)	(0.049)	(0.043)	(0.039)	(0.035)	(0.031)

Notes: results for a time series analysis covering the period 2002Q1-2016Q4 based on an error correction model (ARDL). Each estimation contains a dummy variable for the economic crisis and an exogenous global factor (the real world GDP growth rate). *** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses.

Table B.4. – Cross-country estimates, fiscal variable computed using implicit tax rates

Dep. Variable			**TOT**				
Tax-mix$_{ITR}$							
	Convergence rate	**Long run**	**Δ**	**Lag 1**	**Lag 2**	**Lag 3**	**Lag 4**
Austria	**-0.166****	-0.062	-0.002	-0.010	-0.024	-0.026	-0.053
	(0.075)	(0.076)	(0.079)	(0.073)	(0.064)	(0.053)	(0.039)
Belgium	**-0.394*****	-0.075	0.051	0.050	0.044	0.036	0.008
	(0.140)	(0.064)	(0.060)	(0.053)	(0.049)	(0.043)	(0.033)
Finland	**-0.616*****	-0.218*	0.192	0.106	0.036	0.110	0.114**
	(0.174)	(0.115)	(0.132)	(0.119)	(0.107)	(0.076)	(0.057)
France	**-0.242*****	-0.117	-0.053	-0.004	-0.004	0.048	-0.049
	(0.080)	(0.090)	(0.086)	(0.074)	(0.073)	(0.068)	(0.055)
Germany	**-0.081**	-0.055	0.108***	0.132***	0.064	0.019	0.003
	(0.059)	(0.035)	(0.037)	(0.041)	(0.042)	(0.039)	(0.032)
Greece	**-0.437*****	0.004	-0.020	0.035	0.025	0.00	-0.029
	(0.144)	(0.174)	(0.158)	(0.135)	(0.118)	(0.097)	(0.067)
Ireland	**-0.604*****	0.023*	-0.004	-0.018	-0.018	-0.011	-0.011
	(0.142)	(0.012)	(0.023)	(0.023)	(0.022)	(0.020)	(0.019)
Italy	**-0.377*****	0.498***	-0.052***	-0.436***	-0.350***	-0.277***	-0.172***
	(0.081)	(0.107)	(0.098)	(0.084)	(0.091)	(0.076)	(0.062)
Latvia	**-0.582*****	-0.004	-0.035	-0.056	0.001	-0.023	-0.012
	(0.131)	(0.024)	(0.037)	(0.039)	(0.041)	(0.038)	(0.032)
Luxembourg	**-0.740*****	-0.011	-0.018	-0.036	-0.050**	-0.010	-0.021
	(0.181)	(0.022)	(0.025)	(0.025)	(0.023)	(0.022)	(0.023)
Netherlands	**-0.522*****	0.079	-0.053	-0.036	-0.026	-0.017	-0.003
	(0.178)	(0.058)	(0.047)	(0.036)	(0.029)	(0.020)	(0.014)
Portugal	**-0.428*****	-0.079	0.005	0.024	0.018	-0.022	-0.016
	(0.116)	(0.052)	(0.047)	(0.037)	(0.031)	(0.024)	(0.019)
Slovakia	**-0.425****	0.049	-0.027	-0.011	-0.004	0.007	-0.001
	(0.192)	(0.046)	(0.047)	(0.044)	(0.038)	(0.033)	(0.021)
Spain	**-0.467****	0.111*	-0.040	-0.035	-0.026	-0.018	-0.009
	(0.149)	(0.064)	(0.052)	(0.045)	(0.041)	(0.036)	(0.030)

Notes: results for a time series analysis covering the period 2002Q1-2016Q4 based on an error correction model (ARDL). Each estimation contains a dummy variable for the economic crisis and an exogenous global factor (the real world GDP growth rate). *** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses.