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Fiscal policy and growth in a panel of EU countries over 1995-2017

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JEL Classification: H50; O40

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Fiscal Policy and Growth in a panel of EU countries over 1995-2017[*][†]

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1 Introduction

In the standard Barro-type endogenous growth models (see Barro (1990)) fiscal policy can affect the long run output growth rate. In particular, productive government expenditures and distortionary taxes induce permanent long run growth effects. Following the eruption of the Global Financial Crisis of 2008 the analysis of the effects of fiscal policy on economic growth has received renewed interest since most countries have sought to implement fiscal policies that would allow them to enhance long term growth while maintaining the sustainability of their public finances .

The aim of this paper is to reassess the predictions of the standard Barro-type endogenous growth models drawing on recent developments in the panel time series literature. We adopt the common factor model approach and estimate the effects of fiscal policy for a panel of EU countries using annual data from 1995 to 2017. In particular, we employ the Common Correlated Effects (CCE) estimator developed in Pesaran (2006). To our knowledge, this methodology has not been previously applied to test the predictions of the endogenous growth models.[1]

Regarding our sample, we focus on EU countries as they exhibit a number of interesting characteristics. Specifically, in terms of policy, EU countries are allowed to follow independent national fiscal policies; however, they are subject to common fiscal rules/targets which impose constraints on the policy mix adopted by each country. Moreover, due to their participation in the Union, these countries exhibit increased interdependencies stemming from various economic, political and social reasons. Lastly, they have been subject to large shocks, such as the Global Financial Crisis of 2008 which, as a result of institutional and local factors, have heterogeneous impacts across countries. The potential effects of such interdependencies, which are particularly salient in our panel, have not been accounted for in the relevant literature. As Kapetanios et al. (2011) show, the presence of such dependencies across countries could lead to misleading and possibly inconsistent inference.

In testing whether the predictions of the endogenous growth models are supported by the data, two important challenges have been identified in the related literature. Namely, the potential endogeneity between fiscal variables and output growth and the appropriate specification of the government budget constraint. The endogeneity concerns have been addressed mainly using IV methods and/or GMM estimators (see, for example, Kneller et al. (1999) and Bleaney et al. (2001)). However, Pesaran and Smith (1995) and more recently Eberhardt and Teal (2019) show that in the presence of cross-sectional dependence this identification strategy may be invalid. Regarding the government budget constraint, the implied linear relationship between the fiscal variables may result in significant biases unless the implicit financing of changes in some of the instruments is accounted for (see Kneller et al. (1999) and Gemmell et al. (2011)).

To address these issues we adopt the CCE model, i.e. a methodological approach that

[1]For an overview of the literature see Table A1 in the Appendix.

allows us to incorporate into our analysis the heterogeneous impact of common shocks as well as of local spillover effects both of which induce cross-sectional dependence in the panel. Additionally, it can account for the underlying time series properties of the data (see Chudik et al. (2011)). These issues have largely been neglected in the relevant literature. In this paper, we implement the Common Correlated Effects Pooled estimator of Pesaran (2006), which has been shown to outperform alternative estimators for samples with size similar to ours.

To illustrate the merits of our generalized estimation approach, which encompasses alternative models that have been extensively used in the literature (namely the Pooled OLS, the two-way Fixed Effects and the First Difference models), we compare and contrast the parameter estimates obtained from estimators that do not account for non-stationarity and cross-sectional dependence and those which can accommodate them. Then, based on residual diagnostic tests we can gain valuable insights regarding the presence of potential misspecification in the rival empirical models.

Our main results are: first, the estimates from the CCE model provide strong support to the predictions of the standard endogenous growth model. That is fiscal policy exerts long run effects on growth. More importantly, the CCE estimation generates significantly larger effects of fiscal policy on growth with respect to the other widely used estimation methods. Our comparative analysis indicates that estimation methods which ignore the heterogeneous impact of unobserved common factors across countries (i.e. POLS, FE and FD) could lead to significant underestimation of the fiscal policy effects on growth. Second, the effects of the various fiscal variables on growth are robustly identified. In particular, increases in productive government expenditures enhance growth while increases in distortionary taxation are harmful for growth. The relatively larger negative effects from increases in distortionary taxation eventually lead to negative net effect of fiscal policy on long run growth. Finally, these results are robust to a number of changes in the empirical specification and the sample: the inclusion of additional control variables such as trade openness, the exclusion from the sample of outliers like the Periphery countries and the use of alternative fiscal policy instruments, such as proxies of the fiscal mix and Effective Tax Rates. The latter analysis indicates that shifts away from labour and capital income taxation toward consumption taxes have positive effects on growth.

The rest of the paper is structured as follows: Section 2 develops the estimation approach. Section 3 discusses our data and presents the main empirical results, while section 4 presents the results of our robustness analysis. Section 5 concludes the paper and provides possible extensions. A supplementary online Appendix contains technical details and additional results.

2 Empirical Approach

2.1 Empirical Model

Most of the empirical studies that assess the impact of fiscal policy changes in the context of the standard, Barro-type, endogenous growth model estimate an equation of the following form:

$$y_{it} = \boldsymbol{\beta}'\boldsymbol{x}_{it} + \boldsymbol{\gamma}'\boldsymbol{F}_{it} + u_{it}, i = 1, \ldots, N, t = 1, \ldots, T \tag{1}$$

where y_{it} denotes the growth rate of GDP per capita in country i in period t, $\boldsymbol{x}_{it}$ is a vector of conditioning variables which usually includes labour force growth and the investment rate among others, $\boldsymbol{F}_{it}$ is a vector of fiscal policy variables (e.g. productive and unproductive expenditures, distortionary and non-distortionary taxation and budget deficits/surpluses). In these studies, the error term u_{it} is assumed to have the following form:

$$u_{it} = \alpha_i + \lambda_t + \epsilon_{it} \tag{2}$$

where α_i are country-specific fixed effects, which capture time-invariant heterogeneity, λ_t are the time effects and ϵ_{it} is a standard error term. In this benchmark form equation (1) is the standard two-way Fixed Effects model, where, the time-varying factors, λ_t, are assumed to have a uniform impact across all countries.

In this paper we depart from this literature by employing the Common Correlated Effects (CCE) methodology developed in Pesaran (2006). This approach allows us to model explicitly the heterogeneous impact of unobserved macroeconomic shocks. In the CEE specification the error term, u_{it}, is modeled as having a multifactor structure that consists of the country fixed-effect, α_i and a vector of time-varying unobserved common factors, $\boldsymbol{f}_t$. The heterogeneous impact of these factors is captured by the vector of country-specific 'factor loadings', $\boldsymbol{\lambda}'_i$. Thus, the CCE empirical model takes the following augmented form:

$$y_{it} = \boldsymbol{\beta}'\boldsymbol{x}_{it} + \boldsymbol{\gamma}'\boldsymbol{F}_{it} + u_{it} \tag{3}$$

$$u_{it} = \alpha_i + \boldsymbol{\lambda}'_i\boldsymbol{f}_t + \epsilon_{it} \tag{4}$$

$$\boldsymbol{f}_t = \boldsymbol{\rho}'\boldsymbol{f}_{t-1} + \varepsilon_{it} \tag{5}$$

$$\boldsymbol{x}_{it} = \boldsymbol{\delta}'_{1i}\boldsymbol{g}_t + \boldsymbol{\varrho}_{1i}\boldsymbol{f}_t + \boldsymbol{v}_{1,it} \tag{6}$$

$$\boldsymbol{F}_{it} = \boldsymbol{\delta}'_{2i}\boldsymbol{g}_t + \boldsymbol{\varrho}_{2i}\boldsymbol{f}_t + \boldsymbol{v}_{2,it} \tag{7}$$

The multifactor structure of the error term depicted in equation (4) induces cross-sectional dependence in the panel due to the presence of the $\boldsymbol{f}_t$ factors. Equation (5) captures the potential persistence over time of the factors while allows for the possibility that the factors are non-stationary (when $\boldsymbol{\rho} = \mathbf{1}$). In this case the observables became non-stationary as well. The unobserved factors should not be viewed as merely being omitted variables but, rather, as latent factors which impact macroeconomic performance. This is made evident by equations (6) and (7), where both the $\boldsymbol{x}_{it}$ and $\boldsymbol{F}_{it}$ vectors are allowed to be driven by two sets of unobserved common factors, namely $\boldsymbol{f}_t$ and $\boldsymbol{g}_t$.[2] This setup introduces the possibility of endogeneity, given that the variation in growth rates, fiscal and control variables is driven by the same (sub)set of unobserved factors. We discuss this issue in section 2.4. The common factors can be further decomposed into 'strong' and 'weak' factors as follows:

$$\boldsymbol{\lambda}_i'\boldsymbol{f}_t = \sum_{i=1}^{N} \lambda_i^s f_t^s + \sum_{i=1}^{\infty} \lambda_i^w f_t^w \tag{8}$$

where f_t^s is a set of 'strong' factors that represent large global shocks which affect all the countries in the sample (e.g. the Global Financial Crisis), while f_t^w denotes 'weak' factors which represent localized effects that affect a subset of countries (e.g. spillovers) - see Chudik et al. (2011) and Eberhardt and Presbitero (2015).

2.2 Model Estimation

Subsituting equation (4) into equation (3) yields the following generalized specification:

$$\begin{aligned} y_{it} &= \alpha_i + \boldsymbol{\beta}'\boldsymbol{x}_{it} + \boldsymbol{\gamma}'\boldsymbol{F}_{it} + \boldsymbol{\lambda}_i'\boldsymbol{f}_t + \epsilon_{it} \Rightarrow \\ y_{it} &= \alpha_i + \sum_{j=1}^{m} \beta_j x_{jit} + \sum_{j=1}^{n} \gamma_j F_{jit} + \boldsymbol{\lambda}_i'\boldsymbol{f}_t + \epsilon_{it} \end{aligned} \tag{9}$$

Equation (9) nests different empirical models; here, we focus on the Common Correlated Effects approach developed in Pesaran (2006) and, in particular, we employ the Common Correlated Effects Pooled estimator (henceforth CCEP) which -to our knowledge- has not been previously used in the empirical assessment of fiscal policy effects on growth.[3] For comparison purposes, we also estimate equation (9) using the Pooled OLS (POLS), two way Fixed Effects (FE) and First Difference (FD) estimators. Equation (9) reduces to the FE and FD models when $\boldsymbol{\lambda}_i'\boldsymbol{f}_t$ is replaced by time fixed effects (and, in the FD case, by taking first differences), while the more restrictive POLS model is obtained when we additionally impose $\alpha_i = \alpha, \forall i$.

The basic intuition behind the CCE estimation approach is that since the unobserved factors are common to all countries, they can be proxied using the information provided by the observables of the panel. In particular, Pesaran (2006) shows that by augmenting the empirical model with cross-sectional averages of both the dependent and independent variables, the impact of the unobserved common factors is asymptotically eliminated. Thus,

[2] Eberhardt and Teal (2019) conduct a similar analysis, though, in the context of estimating production functions.

[3] Pesaran (2006) also developed a Mean Group version of the estimator, which is based on estimating country-specific regressions and then averaging the estimated coefficients across countries to obtain the panel estimates, in the spirit of Pesaran and Smith (1995). However, the time dimension of our sample precludes us from using this estimator.

the CCEP model takes the following form:

$$y_{it} = \underbrace{\alpha_i + \sum_{j=1}^{m}\beta_j x_{jit} + \sum_{j=1}^{n}\gamma_j F_{jit}}_{\text{FE}} + \underbrace{\sum_{i=1}^{N} c_i \bar{y}_t D_j + \sum_{j=1}^{m}\sum_{i=1}^{N} d_{ji}^{x}\bar{x}_{jt} D_j + \sum_{j=1}^{n}\sum_{i=1}^{N} d_{ji}^{F}\bar{F}_{jt} D_j}_{\text{Cross-Sectional Augmentation}} + \epsilon_{it} \tag{10}$$

where $\bar{y}_t, \bar{x}_{jt}, \bar{F}_{jt}$ are the cross-sectional means of the covariates and D_j are country dummies. By interacting the country dummies with the cross-sectional means, each country has its own unique coefficient on the means, thus capturing the heterogeneous impact of the unobserved common factors. From equation (10) it is evident that the CCEP estimator is in essence the FE estimator augmented with additional terms that filter out the impact of the unobserved common factors.[4] Pesaran (2006) shows that the CCEP estimator has good small sample properties and seems to outperform the CCEMG in samples whose dimensions is similar to ours. Moreover, Kapetanios et al. (2011) and Chudik et al. (2011) have shown that they can accommodate the potential non-stationarity of the unobservables -and, hence, the observables- and the endogeneity induced by the presence of the unobserved common factors, while also being remarkably robust to structural breaks.

2.3 Government Budget Constraint

One important aspect of the estimation procedure and the interpretation of the results is the appropriate specification of the within period government budget constraint. Since this issue has been extensively analyzed in Kneller et al. (1999) and Bleaney et al. (2001) here we only provide a brief outline. The government budget constraint is a 'closed' system, i.e. an accounting identity which implies that any change in one of its elements must be compensated by a change that is equal and of opposite sign in some other element(s) so that the identity holds. In equation (9) the vector $\boldsymbol{F_{it}}$ contains all the fiscal instruments available i.e. all the elements of the budget constraint. This implies that, by definition, for each country i at time t the following holds:

$$\sum_{j=1}^{n} F_{jit} = 0 \tag{11}$$

where j denotes the number of the fiscal instruments available. Therefore, in order to avoid multicollinearity, at least one of the fiscal instruments must be excluded from the specification so that equation (9) becomes:

$$y_{it} = \alpha_i + \sum_{j=1}^{m}\beta_j x_{jit} + \sum_{j=1}^{n-1}(\gamma_j - \gamma_n)F_{k,it} + \boldsymbol{\lambda_i' f_t} + \epsilon_{it} \tag{12}$$

[4] Moreover, heterogeneous time effects $(\delta_i \tau_t)$ can also be included in the model to capture any remaining time-varying heterogeneity. We report that the latter does not alter our key results.

The omitted fiscal instrument(s) effectively assumes the role of the implicit financing variable(s), that is, the variable that adjusts so that the government budget constraint is satisfied for every t.

Based on equation (12) an intuitive interpretation of the point estimates of the fiscal instruments implies that the coefficients γ_k represent the growth effects of a unit change in the fiscal instrument $F_{k,it}$, offset by a unit change in the omitted variable $F_{n,it}$, which assumes the role of the implicit financing instrument. As expected the estimated coefficient of each fiscal instrument depends on how it is financed. Thus the implicit financing instruments should be those that have a zero effect on long-run GDP growth according to the theoretical model, i.e. nondistortionary taxation and/or unproductive government expenditures. We report that the impact of these categories on long-run growth is indeed zero in our sample, i.e.$\gamma_n = 0$ - see Table A4 in the Appendix.

2.4 Addressing Endogeneity

In our setup, endogeneity may arise via two potential channels, namely because of unobserved common factors and reverse causality. Starting with the first channel, the unobserved common factors may be correlated with the observed explanatory variables leading to an ommitted variables bias (see equations (6) and (7) in section 2). This type of endogeneity bias has not yet been addressed in the relevant empirical literature. Employing the CCE approach this can be directly dealt with via the augmentation of the model with cross-sectional means that account for the presence of the unobservables.

Our aim is to identify the effects of changes in the fiscal variables on growth; however, reverse causality implies that growth rates can also induce changes in the fiscal variables (e.g. via Wagner's law). Most studies have attempted to deal with reverse causality either by using instrumental variable approaches (however as Gemmell et al. (2011) show the task of finding a suitable instrument is difficult) or by estimating the proposed models using the GMM estimators of Arellano and Bond (1991) and Blundell and Bond (1998) that rely on own-instrumentation. It should be noted that the GMM estimators were designed for panels with a small time and a large cross section dimension. The latter condition is not satisfied in our context. In the case of large time dimension panels, the instrument count may become quite large casting doubts on their validity (see Roodman (2009)). Moreover, the standard GMM estimators are not valid in the presence of cross-sectional dependence and non-stationarity in the panel - see Pesaran and Smith (1995) and Eberhardt and Teal (2019). To this end, we follow the approach of Canning and Pedroni (2008) and use weak exogeneity tests in order to determine the direction of causal impact between different sets of variables. We present this approach in more detail in section A.6 of the Appendix.

3 Empirical Results

3.1 Data and Data Properties

We test the predictions of the standard endogenous growth model in a sample of 27 European Union countries during the 1995-2017 period.[5] All the data used in the empirical analysis are obtained from Eurostat.

We focus on this time period in order to ensure that our dataset is consistent across time and countries, without the need for merging and/or imputing data. Most studies, e.g. Gemmell et al. (2011) and Acosta-Ormaechea and Morozumi (2013), compile datasets that have been constructed under different methodological assumptions of the national accounts in order to increase the time dimension of their sample.[6] As such, by using Eurostat data we are able to compute measures of productive/unproductive expenditures on the basis of harmonized general government data.

In addition, other studies (e.g. Kneller et al. (1999), Bleaney et al. (2001), Angelopoulos et al. (2007), ten Kate and Milionis (2019)) opt for the use of period averaged data (e.g. 5-year averages) in order to account for the distortions caused by cyclical fluctuations however we use annual data. The common factor representation is uniquely suited to account for the impact of the business cycle because can account for both large global shocks -i.e. 'strong' factors- and for more localized spillover effects -i.e. 'weak' factors (for more on this issue see Eberhardt and Teal (2013)).

In order to construct the productive and unproductive government expenditure categories, we follow Kneller et al. (1999) and utilize the functional classification of government expenditures (i.e. COFOG). Tax revenue data are classified as distortionary and nondistortionary following the classification provided by Eurostat in terms of direct and indirect taxes (see the Commission (2019) taxation trends report). The set of conditioning variables includes the growth rate of the labour force and a proxy for the investment rate. In particular, we use a measure of investment (defined as the Gross Fixed Capital Formation minus the Dwellings and Transports) that more closely resembles private business investment.[7] Table 1 contains

[5] Croatia is excluded due to lack of sufficient observations. In some of the specifications, the panel is unbalanced due to the lack of some sectoral accounts data for a limited number of countries (namely Spain, Slovenia and Malta).

[6] In particular, a number of papers, e.g. Acosta-Ormaechea and Morozumi (2013) and Gemmell et al. (2011), combine different vintages of IMF's Government Finance Statistics (GFS) database in order to be able to compute productive and unproductive expenditure indicators. However, the relevant data contained in the older GFS vintages were reported on a cash rather than on an accrual basis and referred to the central rather than the general government level. Moreover, there was a significant methodological change introduced with the GFS 2001 manual related to the functional classification of government expenditures and, in particular, an increase of the relevant categories from 10 to 14, which affects the classification of expenditures into productive and unproductive. This implies that all the data series used in these papers are in essence a combination of data produced under different methodological approaches.

[7] Gemmell et al. (2011) use a similar proxy, namely Private Non-Residential Investment rather than Gross Fixed Capital Formation

the theoretical classification of the fiscal instruments and Table 2 contains key descriptive statistics.

Tables 1 and 2 here

Before proceeding with the regression analysis, we carry out some statistical tests in order to investigate the cross-section dependence and time series properties of our sample. In particular, we first apply the weak cross-section dependence test of Pesaran (2015) to all the variables used in the empirical model. Intuitively, weak cross-sectional dependence means that the correlation between units at each point in time converges to zero as the number of cross-sections goes to infinity whereas, under strong dependence this correlation converges to a constant. The results presented in Table A2 of the Appendix indicate that all variables are subject to strong cross-sectional dependencies. Moreover, in order to test for the order of integration of the variables we utilize the CIPS test of Pesaran (2007) which specifically addresses the existence of cross-sectional dependence. In particular, the test is an extension of the well known IPS test introduced in Im et al. (2003), with the main difference being that the group-specific regressions are augmented with cross-sectional averages to capture any dependencies. As in the IPS test, the null hypothesis states that all individual series are non-stationary while under the alternative only a fraction of the series is stationary. The relevant results, presented in Table A3, indicate that we cannot reject the null hypothesis of non-stationarity. Thus, we treat all variables as being $I(1)$.

3.2 Main results

Table 3 summarizes our main results when the set of fiscal instruments includes the budget deficit,[8] productive expenditures and distortionary taxation, while the set of conditioning variables includes labour force growth and our proxy for the investment rate. Our focus is on the estimates of the CCEP model in column [4] which by construction can account for the impact of large macroeconomic shocks and structural breaks; while the diagnostic tests for this model are favourable and indicate the existence of a long-run relationship between fiscal policy instruments and long run growth rate. For comparison purposes, Table 3 also presents estimates from empirical models that have been widely used in the related literature, namely Pooled OLS (POLS), the two-way Fixed Effects (FE) and the First Difference (FD) estimators respectively.

Table 3 here

Overall, the empirical results of Table 3 provide strong support to the predictions of the standard endogenous growth model; namely, fiscal policy matters for growth and exerts

[8]Defined, following Eurostat, as the difference between general government revenue and general government expenditure, resulting in either net lending(+)/surplus or net borrowing(-)/deficit.

long-run persistent effects. Perhaps more importantly, when we apply the CCEP estimation method our results differentiate from the relevant literature. Specifically we document stronger effects of fiscal policy on growth. As we illustrate below, this could be attributed to the fact that the CCEP estimator accounts for both the heterogeneous effects of unobserved common factors and potential non-stationarity.

The CCEP estimator show a clear cut effect of the various fiscal variables on growth. Increases in productive government expenditures enhances growth while increases in distortionary taxation is harmful for growth in EU countries. The CCEP coefficients are significantly larger with respect to the associated coefficients estimated with the other models (see below). In particular, a 1 percentage point increase in productive government expenditures, financed by an adjustment of unproductive expenditures and/or non-distortionary taxation, leads to a permanent increase in the growth rate by almost 0.39 percentage points. In contrast, a 1 percentage point increase in distortionary taxation causes a permanent decrease of growth rates by 0.7 percentage points. Thus, the relatively larger negative effects from increases in distortionary taxation eventually lead to a negative net effect of fiscal policy on long run growth. This is in contrast to the neutral effects identified in Gemmell et al. (2011).

Moreover, the positive coefficient of the budget deficit variable indicates that a 1 percentage point increase in budget deficits leads to a 0.2 percentage point increase in the growth rate. The economic logic implies that budget deficits which finance productive government spending and/or cuts in distortionary taxes boost growth.[9] The coefficients of the conditioning variables imply that the impact of labour force growth is statistically insignificant, while as expected investment induces a strong positive effect on the growth rate. The diagnostic tests -depicted in the lower panel of Table 3- indicate that the residuals of the CCEP model are stationary. We interpret this as an ad hoc test that verifies the presence of a long-run and cointegrating relationship. Moreover, the residuals are weakly cross-sectionally dependent.

Results from the POLS model indicate a significantly smaller impact of fiscal policy on growth while the coefficient on government expenditures is not statistically significant (see column [1]). In this case the residuals are non-stationary, thus, the possibility of spurious results cannot be excluded. The FE model, which assumes an homogeneous impact of the unobserved common factors, produces results qualitatively similar with the CCEP model. However, the magnitude of these coefficients is significantly smaller (see column [2]). These results indicate that ignoring the heterogeneous impact of unobserved factors across countries could lead to significant underestimation of the fiscal policy effects on growth. In the FD model productive expenditures are statistically insignificant, while distortionary taxation has a larger in magnitude negative impact compared to the FE case (and close to the CCEP one see column [3]). Given that the FD is by construction unaffected by nonstationarity –unlike the FE– this result highlights the importance of accounting for the time series properties of the data. However, the results of the FD model cannot be interpreted as representing

[9]This result is in line with the one obtained by Kneller et al. (1999), Bleaney et al. (2001) and Gemmell et al. (2011) - we refer to their paper for additional details.

long-run effects; rather, the FD model may capture short-run effects.

The preceding analysis has dealt with the issue of endogeneity arising from the presence of the unobserved common factors. However, as already mentioned in section 2.4, endogeneity may arise due to reverse causality. In order to examine whether the empirical results are driven by reverse causality we implemented weak exogeneity tests, presented in section A.6 of the Appendix. We report that results from the CCEP model can be interpreted as representing a causal relationship running from the fiscal variables to the growth rates and not vice-versa.

3.3 Impact of unobserved common factors during the Global Financial Crisis

Our baseline results indicate that the estimates obtained from the CCEP model point to significantly larger output effects of fiscal policy, when compared to the estimates obtained from the POLS, FE and FD models. This is potentially due to the fact that the CCEP estimator can account for the heterogeneous impact of unobserved common shocks and non-stationarity. Examples of such shocks in our sample are the Global Financial Crisis of 2008 and the ensuing European debt crisis. In this section we illustrate the importance of accounting for these unobserved shocks by quantifying their average impact over time. To do so, we follow Bond and Eberhardt (2013) and Eberhardt and Teal (2019) and compute what they term as 'common dynamic process'. More specifically, the common dynamic process is an approximation of the average impact of the unobserved common factors and is computed from the coefficient of the $T-1$ differenced time dummies of the FD model. The results are depicted in Figure 1. As can be gleaned from the figure, for the period up to 2007 the average impact of the common factors is quite small. However, in 2008 we observe a significant negative effect associated with the Global Financial Crisis, which persisted up to 2012; afterwards, the effect has remained negative but its magnitude is significantly smaller.

In order to further assess the impact of the unobserved strong common factors, we estimate the FE model in two subsamples: one for the period up to 2007, and one for the 2007-2017 period so as to isolate the impact of the crisis. The results for the pre-crisis sample indicate that productive expenditures and distortionary taxation have coefficients of opposite sign and almost identical in magnitude (0.41 and -0.42 respectively)[10], pointing to an overall neutral effect. On the contrary, in the post-crisis sample the coefficient of distortionary taxation remains significant and is now large in magnitude, while productive expenditures are now negative and insignificant. This result highlights the importance of accounting for large global shocks when estimating the impact of fiscal policy changes on growth to avoid misspecification.[11]

[10] Results are available upon request.

[11] It should be noted here that due to the relatively small time dimension of the sample, a similar analysis for the CCEP model cannot be conducted.

4 Robustness

In this section we test the robustness of our results to the following changes in the empirical model and the sample: firstly, we estimate a version of the main model that augments the set of control variables with trade openness. Secondly, we omit from the sample the countries of the European periphery (i.e. Portugal, Ireland, Greece and Spain). Our reasoning is that these countries could be considered as outliers given that they exhibited a significant degree of variation both in GDP growth and in the fiscal variables during the period examined. Finally, we assess the impact of changes in the fiscal policy mix, that is, in the composition of government expenditures and the tax structure. To obtain a better insight into the effects of changes in the various tax categories we employ estimates of aggregate effective tax rates (ETR) on labour and capital income and on consumption.

4.1 Including Trade Openness

In most of the cross-country analyses of the output effects of fiscal policy, a number of time-varying factors are included in the model as additional control variables in order to account for country-specific growth characteristics.[12] Arin et al. (2019) using Bayesian Model Averaging examine which of the abovementioned variables are robust growth determinants and their evidence suggests that only trade openness appears to have a significant and robust impact on growth. Given that their sample is quite similar to ours, both in terms of countries covered and the time period, we opt to augment our model with trade openness. Results are presented in Table 4. Openness appears to be positively related to long-run growth while the coefficient of productive expenditures remains positive but it is now statistically insignificant. This result is consistent with the literature that examines the relationship between government size and openness. In general, more open economies tend to have larger governments in order to mitigate the larger external risks they are faced with (e.g. see Rodrik (1998)). However, the overall effect of fiscal policy changes remains negative, due to the large negative impact of distortionary taxation.

Table 4 here

4.2 Excluding the Periphery Countries

Following the outbreak of the Global Financial Crisis, the countries of the so called Periphery– namely, Greece, Ireland, Portugal and Spain– implemented fiscal adjustment programmes which resulted in significant shifts in the expenditure and tax policy mix. In order to assess the impact of such abrupt fiscal changes on our results, we exclude these countries from the

[12]This set of variables stems from the literature of growth determinants (see Durlauf et al. (2008) and Sala-I-Martin et al. (2004)) and includes trade openness, inflation, fertility rates, human capital proxies and indices of institutional quality (see, among others, Afonso and Jalles (2016), Angelopoulos et al. (2007), Lee and Gordon (2005), Mendoza et al. (1997) and Romero-Ávila and Strauch (2008)).

sample. Results presented in Table 5 are in line with those in Table 3. For example, the effect of distortionary taxation remains significantly large and negative while at the same time the positive effect of productive expenditures on growth is relatively larger in magnitude across all estimators (with the exception of POLS). It is worth noticing that under the CCEP model (see column [4] of the Table), which is our preferred specification, the impact of productive expenditures is almost double in magnitude compared to the baseline case. We attribute this result to the fact that in some Periphery countries, the policy mix was less favourable for growth. Post 2008 these countries, mainly due to the fiscal consolidation which occurred, have increased distortionary vis-a-vis nondistortionary taxes while have decreased productive expenditures vis-a-vis unproductive.

Table 5 here

4.3 Changes in the Policy Mix

The empirical estimates presented thus far indicate that changes in the size of productive expenditures and/or distortionary taxation, financed by equal and offsetting changes in unproductive expenditures and non-distortionary taxation, have significant long-run output effects.

In this section we assess the impact of changes in the fiscal policy mix, that is, the composition of government expenditures (using as a proxy the share of productive over total government expenditures) and the tax structure (proxied by the share of distortionary in total tax revenues). Further, we explore in more detail the impact of changes in the tax structure by using estimates of aggregate Effective Tax Rates (henceforth, ETRs). Effective tax rates have the advantage of directly corresponding to the tax categories used in most theoretical models and will allow us to assess whether shifting the burden away from a distortionary tax (e.g. labour or capital) toward a less distortionary category (consumption) has a positive output effect. Moreover, they can better approximate the complexity of each country's tax system, while also providing measures suitable for international comparisons. Section A.5 of the Technical Appendix provides a brief description of the methodology used for the computation of the indicators along with some descriptive statistics.[13]

Table 6 here

The results presented in Table 6 indicate that an increase in the share of productive government expenditures is associated with positive and significant effects on long-run growth, irrespective of the changes in the tax structure. Moreover, shifts away from capital income taxation are associated with positive growth effects, especially in the case where the tax burden is shifted toward consumption, indicating that -for this sample- capital taxation is the most harmful policy option for growth. Overall, we conclude that a shift in the expenditure

[13] Kostarakos and Varthalitis (2019) compute ETRs over the 1995-2017 period for EU countries.

mix toward a larger share of productive expenditures combined with a shift away from more distortionary tax categories toward taxes on consumption has a significant positive effect on long-run growth rates.

5 Conclusion and Possible Extensions

This paper reassesses the predictions of the standard endogenous growth models regarding the long-run output effects of changes in fiscal policy. We apply an estimation approach, which accounts for the heterogeneous impact of global macroeconomic shocks, on a panel of EU countries.

The main results lend strong support to the predictions of the endogenous growth model and indicate that when the impact of large shocks is not accounted for, the effects of fiscal policy on growth are underestimated.

Here we discuss potential extensions. Our analysis focuses on the impact of changes in the composition of the fiscal structure –i.e. the policy mix– taking the efficiency of the public sector as given. However, the quality of public administration plays a central role in efficiently allocating resources towards more productive expenditures, which could lead to higher growth rates in the long-run. Exploring the policy mix-efficiency nexus will provide further insight into the mechanisms via which fiscal policy affects output.

Another interesting extension would be the analysis of the long-run distributional impact of fiscal policy and, in particular, whether the policy mix that emerges as growth-enhancing is sufficient to mitigate the effects of macroeconomic shocks on income inequality.

Finally, it would also be interesting to assess the impact of expenditure- and/or tax-neutral changes in fiscal policy, utilizing disaggregated data on the relevant fiscal instruments (e.g. expenditures in education and health, taxes on personal and corporate income etc.). We leave these extensions for future work.

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6 Tables and Figures

6.1 Data

6.1.1 Classification of Variables

Table 1: Classification of Variables

Theoretical Classification	**National Accounts Classification**
Nondistortionary Taxation	Taxes on Production and Imports
Distortionary Taxation	Current Taxes on Income and Wealth Capital Taxes Net Social Contributions
Productive Expenditures	General Public Services Defense Housing Health Education
Unproductive Expenditures	Public Order and Safety Economic Affairs Recreation, Culture and Religion Social Protection

Note: The classification of expenditures is based on Kneller et al. (1999) and Gemmell et al. (2011), while the classification of tax categories follows the European Commission definition (see the "Taxation Trend in the EU" annual report)

6.1.2 Descriptive Statistics

Table 2: Descriptive Statistics

Variable	Mean	St. Dev.	Min (country)	Max (country)	Observations
Real GDP p.c growth (% p.a.)	2.46	3.66	-16.65 (Bulgaria)	24.05 (Ireland)	621
Investment Rate	15.61	3.67	3.86 (Bulgaria)	31.09 (Slovakia)	621
Labour Force Growth (% p.a.)	0.49	1.49	-8.83 (Romania)	6.84 (Luxembourg)	621
Productive Expenditures	19.98	3.23	12.58 (Ireland)	29.46 (Lithuania)	621
Unproductive Expenditures	23.97	4.45	11.89 (Bulgaria)	45.29 (Ireland)	621
Distortionary Taxation	22.71	5.16	10.86 (Portugal)	34.57 (Belgium)	621
Nonistortionary Taxation	13.43	2.58	8.39 (Ireland)	24.29 (Sweden)	621
Budget Deficit/Surplus	-2.69	4.17	-31.79 (Ireland)	7.79 (Luxembourg)	621
Consumption ETR (%)	18.49	3.62	8.976 (Spain)	64.8 (Luxembourg)	591
Labour ETR (%)	39.6	9.86	8.96 (Cyprus)	64.8 (Denmark)	593
Capital ETR (%)	18.22	8.83	4.63 (Lithuania)	51.4 (Sweden)	593
Corporate ETR (%)	19.49	9.23	2.28 (Lithuania)	65.2 (Poland)	584

Note: All variables are shares of GDP, unless otherwise specified. All National Accounts and are from Eurostat and, in particular, the Main GDP Aggregates per capita series [nama_10_pc], the GDP and Main Components (Output, Expenditure and Income) series [nama_10_gdp] and the Gross Fixed Capital Formation by Asset Type series [nama_10_an6]. The expenditures data are from the Government Expenditure, Revenue and Aggregates series [gov_10a_main] and the General Government Expenditure by Function series [gov_10a_exp], while the revenue data are from the Main National Accounts Tax Aggregates series [gov_10a_taxag]. All ETR data are from Kostarakos and Varthalitis (2019).

6.2 Tables

6.2.1 Baseline Regressions

Table 3: Baseline Results

	POLS [1]	FE [2]	FD [3]	CCEP [4]
Investment	0.244^{***}	0.318^{***}	0.103	0.389^{**}
	(0.000)	(0.000)	(0.616)	(0.025)
Labour Force	0.0937	0.150	0.09	0.112
	(0.350)	(0.235)	(0.275)	(0.303)
Budget	0.130^{***}	0.171^{***}	0.061	0.201^{***}
	(0.001)	(0.000)	(0.108)	(0.004)
Productive exp.	-0.0295	0.192	0.125	0.368^{*}
	(0.672)	(0.180)	(0.725)	(0.095)
Distortionary tax.	-0.170^{***}	-0.350^{***}	-0.539^{***}	-0.595^{***}
	(0.000)	(0.002)	(0.000)	(0.000)
CD	-0.171	0.506	0.398	-0.257
CD (p-val)	0.864	0.613	0.691	0.798
CIPS	-0.590	-0.292	-6.249	-7.531
CIPS (p-val)	0.278	0.385	0.001	0.000
Observations	617	617	590	617

p-values in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: FE - Fixed Effects estimator with time dummies, CCEP - Common Correlated Effects Pooled estimator. *p*-values in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

CD Test: Pesaran (2015) test for the null of weak cross-sectional dependence of the residuals. Results obtained using the user-written Stata routines *xtcd* by Eberhardt (2011) and *xtcd2* by Ditzen (2018)

CIPS: Pesaran (2007) test for the null hypothesis of non-stationary residuals The results reported are based on two lags (full results available upon request) and were obtained using the *multipurt* user-written Stata routine by M. Eberhardt.

6.2.2 Impact of Unobserved Common Factors

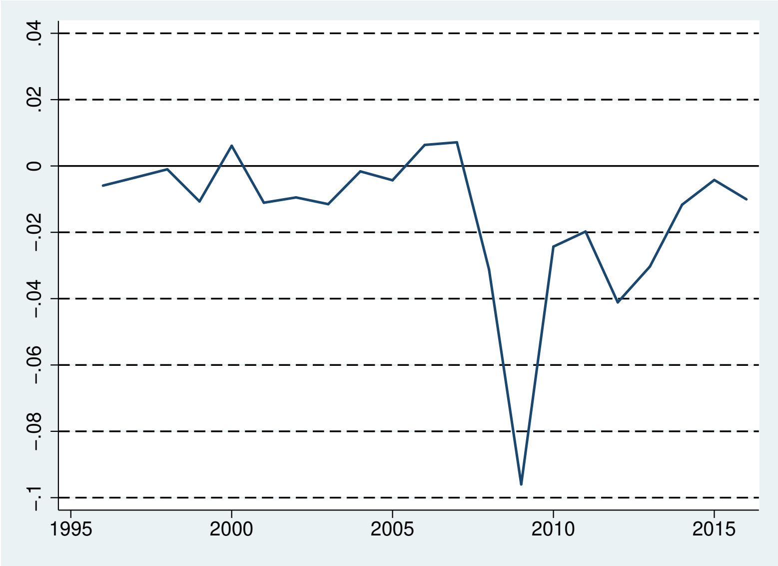

Figure 1: The Evolution of the Average Impact of Common Factors

Note: Derived from column 3 of Table 3

6.2.3 Including Trade Openness

Table 4: Effects of Trade Openness

	POLS [1]	FE [2]	FD [3]	CCEP [4]
Investment	0.244^{***}	0.335^{**}	0.091	0.434^{**}
	(0.000)	(0.004)	(0.659)	(0.000)
Labour Force	0.0649	0.117	0.089	0.126
	(0.557)	(0.331)	(0.288)	(0.256)
Budget	0.127^{**}	0.156^{***}	0.051	0.179^{**}
	(0.001)	(0.000)	(0.132)	(0.024)
Productive Exp.	−0.0124	0.194	0.107	0.341
	(0.862)	(0.162)	(0.753)	(0.180)
Distortionary Tax.	-0.171^{***}	-0.326^{***}	−0.511	-0.582^{***}
	(0.000)	(0.002)	(0.115)	(0.01)
Trade Openness	0.0025	0.0231	0.043	0.0774^{***}
	(0.382)	(0.130)	(0.11)	(0.007)
CD	−0.149	−0.565	0.388	−0.399
CD (p-val)	0.882	0.572	0.698	0.690
CIPS	−0.668	−0.340	−5.545	−7.764
CIPS (p-val)	0.252	0.367	0.003	0.000
Observations	617	617	590	617

p-values in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6.2.4 Excluding Periphery Countries

Table 5: Baseline Results excluding Periphery Countries

	POLS [1]	FE [2]	FD [3]	CCEP [4]
Investment	0.257^{***}	0.338^{**}	0.241	0.317^{*}
	(0.000)	(0.000)	(0.194)	(0.057)
Labour Force	0.0815	0.216	0.098	0.134
	(0.455)	(0.167)	(0.224)	(0.239)
Budget	0.123^{**}	0.192^{***}	0.079^{*}	0.202^{**}
	(0.021)	(0.000)	(0.087)	(0.04)
Productive Exp.	-0.0117	0.2486	0.329	0.474^{**}
	(0.874)	(0.143)	(0.333)	(0.041)
Distortionary tax.	-0.159^{***}	-0.331^{**}	-0.859^{**}	-0.532^{***}
	(0.001)	(0.02)	(0.034)	(0.002)
Observations	525	525	502	525
CD	-0.035	-0.454	-0.092	1.019
CD (p-val)	0.972	0.650	0.927	0.308
CIPS	-1.009	-1.212	-6.313	-4.495
CIPS (p-val)	0.156	0.113	0.000	0.000

p-values in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6.2.5 Changes in the Fiscal Policy Mix

Table 6: Changes in the Fiscal Policy Mix

	(1)	(2)	(3)	(4)
Investment	0.491^{***}	0.422^{**}	0.518^{***}	0.384^{**}
	(0.001)	(0.012)	(0.009)	(0.018)
Labour Force	0.104	0.151	0.164	0.0939
	(0.36)	(0.135)	(0.150)	(0.436)
Budget	0.0838	0.0906	0.087	0.111
	(0.299)	(0.274)	(0.286)	(0.160)
Productive share	0.241^{*}	0.227^{*}	0.254^{*}	0.192^{**}
	(0.059)	(0.082)	(0.07)	(0.015)
Distortionary share	-0.310^{***}			
	(0.000)			
$\frac{\tau^l}{\tau^k}$		0.0125		
		(0.103)		
$\frac{\tau^l}{\tau^c}$			-0.0055	
			(0.62)	
$\frac{\tau^c}{\tau^k}$				0.0336^{***}
				(0.009)
Observations	594	587	587	589
CD	0.177	0.356	0.525	0.541
CD (p-val)	0.859	0.722	0.600	0.588
CIPS	-6.236	-5.796	-5.072	-4.899
CIPS (p-val)	0.000	0.001	0.000	0.000

p-values in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Malta is excluded due to lack of data on Effective Tax Rates

A Appendix - Intended for online publication

A.1 Literature Review

Table A1: Selective Literature Review

Author	Sample	Period	Averaging	Dep. Variable	Estimator	Model	Fiscal Instruments	GBC
Fiscal Policy and Growth								
Angelopoulos et al. (2007)	23 OECD countries	1970-2000	5-year	GDP growth	2FE	Static	productive exp. (share of total exp.), tax revenue (% GDP), government exp. (% GDP), ETRs	No
Afonso and Alegre (2011)	15 EU countries	1971-2006	Annual	GDP pc growth	AB GMM	Dynamic	FCE^{GG}, Investment^{GG}, economic classification direct taxes, indirect taxes, SSC	No
Afonso and Furceri (2010)	OECD countries	1970-2004	5-year	GDP pc growth	2FE	Static	FCE^{GG}, Investment^{GG}, subsidies, transfers direct taxes, indirect taxes, SSC	No
Afonso and Jalles (2014)	155 countries	1970-2008	5-year	GDP pc growth	FE, MM, LAD, LSDV-C,IV-GLS, GMM	Static, dynamic	economic and functional classification of expenditures GS taxes, income taxes, property taxes, SSC	No
Benos (2009)	14 EU countries	1990-2006	Annual	GDP growth	AB GMM, BB GMM	Dynamic	economic and functional class. of exp. capital tax, income tax, taxes on production, SSC	Yes
Bleaney et al. (2001)	22 OECD countries	1970-1995	5-year	GDP pc growth	2FE, AH-IV	Static, dynamic	productive, distortionary, budget	Yes
Colombier (2009)	21 OECD countries	1970-2001	5-year MA	GDP pc growth	MM	Static	total exp. (% GDP), total revenue (% GDP), total tax (% GDP)	No
Gemmell et al. (2011)	17 OECD countries	1970-2004	Annual	GDP growth	PMG	Dynamic	productive, distortionary, budget	Yes
Kneller et al. (1999)	22 OECD countries	1970-1995	5-year	GDP pc growth	2FE, FD-IV	Static, dynamic	productive, distortionary, budget	Yes
Romero-Ávila and Strauch (2008)	15 EU countries	1960-2001	Annual	GDP pc growth	Distributed lag	Dynamic	FCE^{GG}, Investment^{GG}, transfers direct taxes, indirect taxes	No

Estimators: 2FE: Two-way Fixed Effects, AB GMM: Arellano-Bond GMM, AH IV: Anderson-Hsiao IV, BB GMM: Blundell-Bond GMM, FD IV: First difference instrumental variables, IV GLS: Instrumental variables Generalized Least Squares, LAD: Least Absolute Deviations, LSDV-C: bias corrected Least Squares Dummy Variable, MM: modified robust M-estimator, PMG: Pooled Mean Group
Fiscal Instruments: CIT: Corporate Income Tax, GS: Goods and Services Tax, PIT: Personal Income Tax, SSC: Social Security Contributions, ETR: Effective Tax Rates, FCE^{GG}: Final consumption expenditure of general government, Investment^{GG}: investment of general government, economic classification of expenditures: compensation of employees, subsidies, social benefits, functional classification of expenditures: general public services, defense, education, health, social protection etc.

Table A1 (cont'd): Selective Literature Review

Author	Sample	Period	Averaging	Dep. Variable	Estimator	Model	Fiscal Instruments	GBC
Taxation and Growth								
Acosta-Ormaechea and Morozumi (2013)	69 countries	1970-2008	Annual	GDP growth	PMG	Dynamic	PIT, CIT, SSC, GS, Trade, Property	Yes
Arnold et al. (2011)	21 OECD countries	1971-2004	Annual	GDP pc	PMG	Dynamic	PIT, CIT, SSC, GS, Trade, Property	Yes
Arachi et al. (2015)	15 OECD countries	1965-2011	Annual	GDP pc growth	CCE-MG	Dynamic	ETRs	Yes
Baiardi et al. (2019)	34 OECD countries	1971-2014	Annual	GDP	CCE-PMG	Dynamic	PIT, CIT, Cons., Property	Yes
McNabb (2018)	100 countries	1980-2012	Annual	GDP pc growth	PMG	Dynamic	PIT, CIT, SSC, GS, Trade, Property	Yes
Mendoza et al. (1997)	18 OECD countries	1965-1991	5-year	GDP pc growth	POLS, FE	Static	ETR	No
ten Kate and Milionis (2019)	77 countries	1965-2014	5-year	GDP	2FE, GMM	Static, dynamic	ETR capital income	Yes
Expenditure and Growth								
Acosta-Ormaechea and Morozumi (2013)	56 countries	1971-2010	5-year	GDP pc growth	BB GMM	Dynamic	economic and functional classification of expenditure	Yes
Acosta-Ormaechea and Morozumi (2017)	82 countries	1971-2011	8-year	GDP pc growth	BB GMM	Dynamic	economic and functional classification of expenditure	Yes
Chu et al. (2018)	59 countries	1993-2012	5-year forward MA	GDP pc growth	2FE, BB GMM	Static, Dynamic	deficit, productive and unproductive exp., tax and non-tax revenue	Yes
Gemmell et al. (2016)	17 OECD countries	1970-2008	Annual	GDP pc	PMG	Dynamic	functional classification of expenditure	Yes

Estimators: 2FE: Two-way Fixed Effects, AB GMM: Arellano-Bond GMM, AH IV: Anderson-Hsiao IV, BB GMM: Blundell-Bond GMM, FD IV: First difference instrumental variables, IV GLS: Instrumental variables Generalized Least Squares, LAD: Least Absolute Deviations, LSDV-C: bias corrected Least Squares Dummy Variable, MM: modified robust M-estimator, PMG: Pooled Mean Group

Fiscal Instruments: CIT: Corporate Income Tax, GS: Goods and Services Tax, PIT: Personal Income Tax, SSC: Social Security Contributions, ETR: Effective Tax Rates, FCE^{GG}: Final consumption expenditure of general government, Investment^{GG}: investment of general government, economic classification of expenditures: compensation of employees, subsidies, social benefits, functional classification of expenditures: general public services, defense, education, health, social protection etc.

A.2 Cross-Sectional Dependence Tests

Table A2: Cross-Sectional Dependence Properties of the Variables I

Panel A: Levels				Panel B: First Difference			
	g	n	I		g	n	I
$\hat{\rho}$	0.543	0.054	0.206	$\hat{\rho}$	0.57	0.03	0.19
$\|\hat{\rho}\|$	0.547	0.213	0.353	$\|\hat{\rho}\|$	0.57	0.24	0.25
CD	61.58	14.553	88.523	CD	49.75	2.289	9.867
CD(p-val)	0.000	0.000	0.000	CD(p-val)	0.000	0.022	0.000

Panel C: AR(2)				Panel D: AR(2) CCE			
	g	n	I		g	n	I
$\hat{\rho}$	0.551	0.04	0.181	$\hat{\rho}$	0.013	-0.03	-0.006
$\|\hat{\rho}\|$	0.555	0.211	0.247	$\|\hat{\rho}\|$	0.248	0.237	0.223
CD	47.34	3.46	15.56	CD	1.14	-2.24	-0.55
CD(p-val)	0.000	0.001	0.000	CD(p-val)	0.254	0.025	0.582

Table A2 (cont'd): Cross-Sectional Dependence Properties of the Variables II

	Panel A: Levels				Panel B: First Difference		
	Budget	Productive	Distortionary		Budget	Productive	Distortionary
$\hat{\rho}$	0.259	0.203	0.037	$\hat{\rho}$	0.11	0.25	0.06
$\hat{\lvert\rho\rvert}$	0.291	0.394	0.366	$\hat{\lvert\rho\rvert}$	0.20	0.31	0.19
CD	38.655	88.715	89.437	CD	9.867	21.731	4.935
CD(p-val)	0.000	0.000	0.000	CD(p-val)	0.000	0.000	0.000

	Panel C: AR(2)				Panel D: AR(2) CCE		
	Budget	Productive	Distortionary		Budget	Productive	Distortionary
$\hat{\rho}$	0.177	0.237	0.035	$\hat{\rho}$	-0.029	0.029	0.035
$\hat{\lvert\rho\rvert}$	0.229	0.292	0.198	$\hat{\lvert\rho\rvert}$	0.211	0.245	0.216
CD	15.22	20.38	3.05	CD	-2.52	1.658	-1.758
CD(p-val)	0.000	0.000	0.002	CD(p-val)	0.012	0.097	0.079

Note: We present the average ($\hat{\rho}$) and average absolute correlation coefficients $\hat{\lvert\rho\rvert}$ for GDP per capital growth (g), labour force growth (n) and the rate of investment (I). CD reports the Pesaran (2015) weak cross-section dependence statistic, which is distributed N(0,1) under the null of weak cross-section dependence. Panels A and B test the variable series in levels and first differences respectively. In Panel C each of the variables in levels is entered into a time-series regression $z_{it} = a_{0i} + a_{1i}z_{i,t-1} + a_{2i}z_{i,t-2} + a_{3i}t + \epsilon_{it}$, conducted separately for each country i. In Panel D the country-specific regressions are augmented with cross-sectional averages of all variables instead of a linear trend. The correlations and cross-section dependence statistics in Panels C and D are then based on the residuals from these AR(2) regressions. We used the Stata routine xtcd2 written by Ditzen (2018).

A.3 Panel Unit Root Tests

Table A3: Pesaran (2007) CIPS test

GDP growth			Lab. Force			Inv.			Budget		
lags	Z[t-bar]	p-val.	lags	Z[t-bar]	p-val.	lags	Z[t-bar]	p-val.	lags	Z[t-bar]	p-val.
0	-3.684	0.000	0	-12.196	0.000	0	-0.707	0.240	0	-8.631	0.000
1	-1.975	0.024	1	-5.575	0.000	1	0.114	0.545	1	-8.399	0.000
2	-0.092	0.463	2	-0.640	0.261	2	2.723	0.997	2	-2.379	0.009
3	1.403	0.920	3	2.474	0.993	3	4.966	1.000	3	0.136	0.554

Productive			Distortionary			Unprodutive			Nondistortionary		
lags	Z[t-bar]	p-val.	lags	Z[t-bar]	p-val.	lags	Z[t-bar]	p-val.	lags	Z[t-bar]	p-val.
0	-0.859	0.195	0	-0.104	0.459	0	-3.755	0.000	0	2.048	0.980
1	-0.766	0.222	1	0.065	0.747	1	-1.852	0.032	1	3.060	0.999
2	-0.471	0.681	2	3.199	0.999	2	-0.905	0.183	2	2.761	0.997
3	-2.445	0.007	3	3.197	1.000	3	-0.129	0.443	3	5.407	1.000

τ^l			τ^k			τ^c			τ^{corp}		
lags	Z[t-bar]	p-val.	lags	Z[t-bar]	p-val.	lags	Z[t-bar]	p-val.	lags	Z[t-bar]	p-val.
0	-0.739	0.230	0	-0.289	0.386	0	0.473	0.682	0	-3.128	0.001
1	-0.426	0.335	1	1.880	0.970	2	1.797	0.964	2	0.010	0.504
2	2.909	0.998	2	3.500	1.000	2	3.903	1.000	2	1.263	0.897
3	2.895	0.998	3	5.179	1.000	3	6.022	1.000	3	2.412	0.997

Note: The null hypothesis of the CIPS test is that of non-stationarity

A.4 Testing for the Growth-Neutral Elements of the Budget

Table A4: Estimations based on the CCEP model

	[1]	[2]	[3]
Investment	0.501^{***}	0.501^{***}	0.534^{***}
	(0.000)	(0.000)	(0.000)
Labour Force	0.0871	0.0871	0.127
	(0.325)	(0.325)	(0.200)
Budget	0.254^{**}	0.125^{*}	0.200^{***}
	(0.003)	(0.050)	(0.000)
Productive exp.	0.482	0.353^{*}	0.387^{***}
	(0.118)	(0.078)	(0.003)
Distortionary tax.	-0.768^{***}	-0.639^{***}	-0.703^{**}
	(0.000)	(0.001)	(0.000)
Nondistortionary tax.	-0.129		
	(0.181)		
Unproductive exp.		-0.129	
		(0.181)	
Observations	617	617	617

p-values in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: In order to test whether nondistortionary taxation and unproductive expenditures have the expected from theory neutral-growth effects, we follow the approach outlined in section 3.2. As can be seen in columns [1] and [2], both instruments have coefficients equal in magnitude and insignificant. Also note that, because of the government budget constraint, the coefficients of the conditioning variables do not change in columns [1] and [2].

A.5 Effective Tax Rates

Effective tax rates are aggregate tax measures which essentially classify all forms of tax receipts into revenues from labour, capital and consumption. As such, they closely correspond to the tax rates used in most theoretical dynamic macroeconomic models and essentially represent the wedge distorting the optimizing behaviour of economic agents. The main advantages of using effective tax rates are the following: first, they are relatively easy to compute using readily available data from the National Accounts and Revenue Statistics and since they exploit the consistency of the National Accounts, they are suitable for international comparisons. Moreover, they separate the tax on labour income from the tax on capital income, a distinction not available in the Revenue Statistics series, and which allows for better comparability with tax rates in theoretical macro models. Finally, given that the effective tax rate estimates are computed using the actual, realized amounts collected from each tax category, they incorporate the net combined effect of tax credits, exemptions and deduction of each country's tax system. On the other hand, the main disadvantage of the effective tax rates is that they do not take into account the information regarding statutory tax rates and the income distribution per tax bracket.

In Kostarakos and Varthalitis (2019)[14], following Carey and Rabesona (2002) and Dellas et al. (2017), we compute ETRs for all the EU member states over the 1995-2017 period, using data from Eurostat and, in particular, data from the Annual National Accounts Series (nama_10_gdp), the Non-Financial Annual Sector Accounts (nasa_10_nf_tr) and the Tax Aggregates of Annual Government Finance Statistics (gov_10a_taxag). All the relevant data, along with their accompanying ESA 2010 codes are presented in Table A5.

The effective tax rate on consumption, τ^c is computed as follows:

$$\tau^c = \frac{D2 - D214C - D214F}{P2 + P3}$$

A well-documented problem related to the computation of effective tax rates on labour and capital income is that tax revenue sources do not provide a breakdown of personal income tax into its labour and capital components. To address this issue, we follow Mendoza et al. (1994) and assume that both the labour and capital income of households are taxed at the same rate, τ^h. The effective tax rate on household income is given by:

$$\tau^h = \frac{D51A\_C1}{(D1 - D611 - D613) + (BA43G^{hh} - P51C^{hh}) + (D41r^{hh} - D41p^{hh}))}$$

Then, the effective tax rate on labour income is given by:

$$\tau^l = \frac{\tau^h(D1 - D611 - D613) + D611 + D613}{D1}$$

[14]The database with the estimates of the effective tax rates is avaialble at `https://sites.google.com/site/ikostarakos/effective-tax-rates`

Table A5: Data used for ETR computation

Tax Revenue		National Accounts	
ESA Code	**Definition**	**ESA Code**	**Definition**
D2	Taxes on Production and Imports	B2A3G^{hh}	GOS of Households
D214B	Stamp Taxes	B2A3G^{nfc}	GOS of NFC
D214C	Taxes on Financial and Capital Transactions	B2A3G^{fc}	GOS of FC
D214F	Taxes on Lotteries, Gambling etc.	B2A3G^{total}	GOS of Total Economy
D29	Other Taxes on Production	D2	Compensation of Employees
D29H	Other Taxes on Production n.e.c.	D41P^{hh}	Interest Income Paid HH
D59A	Current Taxes on Capital	D41R^{hh}	Interest Income Received HH
$D51^{nfc}$	Taxes on Income NFC	D611	Employers' Actual SSC
$D51^{fc}$	Taxes on Income FC	D613	Household Actual SSC
$D51A\_C1$	Taxes on Individual or Household Income	P2	Government Intermediate C
$D51B\_C2$	Taxes on the Income and Profits of Corp.	P3	Household FCE
D91	Capital Taxes	P51C	Consumption of Fixed Capital

Note: Data are from Eurostat National Accounts and Tax Revenue Database (see Appendix A.5).

while the effective tax rate on capital income is given by:

$$\tau^k = \frac{\tau^h(B2A3G^{hh} - P51C^{hh} + D41r^{hh} - D41p^{hh}) + CAPT}{B2A3G^{total} - P51C^{total}}$$

where $CAPT = D214B + D214C + D29 + D29H + D51B\_C2 + D51D + D59 + D91$
Finally, the effective tax rate on corporate income (for non-financial corporations) is given by:

$$\tau^{corp} = \frac{D51^{ncf}}{B2A3G^{nfc} - P51C^{nfc}}$$

A.6 Direction of Causation

As already stated, the Common Correlated Effects approach is uniquely suited to address concerns related to endogeneity arising from the presence of unobserved common factors, which may drive both the observable inputs (i.e. the fiscal and the conditioning variables) and GDP per capita growth.

However, this approach is not immune to reverse causality, a concern that has been a central point in the empirical fiscal policy and growth literature. As indicated above, the standard approach utilized in the literature in an attempt to tackle reverse causality has been the use of instrumental variable approaches. In particular, most studies employ GMM-type estimators (Arellano and Bond (1991), Blundell and Bond (1998)) which have the advantage of relying on own-instrumentation. However, as noted in Eberhardt and Teal (2019), these estimators assume stationarity and cross-section dependence. If any of these assumptions is violated, as is the case in our sample, then this instrumentation strategy is invalid.

In order to determine the direction of causation between the various sets of variables, we follow the approach of Canning and Pedroni (2008), which has also been used by Eberhardt and Presbitero (2015) and Eberhardt and Teal (2019).

In particular, given that a cointegrating relationship exists among the variables, as indicated by the stationary residuals, then by the Granger Representation Theorem (Engle and Granger (1987)) we know that the cointegrated series can be represented as dynamic error correction models. In this case, these take the following form:

$$\Delta y_{it} = \alpha_{11} + \lambda_{11,i}\hat{u}_{i,t-j} + \sum_{j=1}^{K}\phi_{11,ij}y_{i,t-j} + + \sum_{j=1}^{K}\phi_{12,ij}x_{i,t-j} + \sum_{j=1}^{K}\phi_{13,ij}F_{i,t-j} + \epsilon_{1,it}$$
$$\Delta x_{it} = \alpha_{21} + \lambda_{21,i}\hat{u}_{i,t-j} + \sum_{j=1}^{K}\phi_{21,ij}y_{i,t-j} + + \sum_{j=1}^{K}\phi_{22,ij}x_{i,t-j} + \sum_{j=1}^{K}\phi_{23,ij}F_{i,t-j} + \epsilon_{2,it}$$
$$\Delta F_{it} = \alpha_{31} + \lambda_{31,i}\hat{u}_{i,t-j} + \sum_{j=1}^{K}\phi_{31,ij}y_{i,t-j} + + \sum_{j=1}^{K}\phi_{32,ij}x_{i,t-j} + \sum_{j=1}^{K}\phi_{33,ij}F_{i,t-j} + \epsilon_{3,it}$$

where $\hat{u}_{it} = y_{it} - \hat{\beta}x_{it} - \hat{\gamma}F_{it}$ is the disequilibrium term. For a long-run relationship to exist, at least one of the λ's must be different from zero; in particular, if $\lambda_{11} \neq 0$ then x_{it}, F_{it} have a causal impact on y_{it} (which can be denoted as $x_{it}, F_{it} \rightarrow y_{it}$). If $\lambda_{12}, \lambda_{13}$ are different from zero as well, then all variables are simultaneously determined and no causal relationship can be identified.

We performed the weak exogeneity test for the FE as well as the CCEP specification, which is the preferred one based on the diagnostic tests. In line with the Pesaran (2006) approach, the error correction models were augmented with cross-section averages of both the dependent and independent variables, including their lags[15]. The relevant results are

[15] I only included one and two lags of the cross-sectional averages, due to the limited time dimension of the

presented in Table A6. The error-correction models were estimated at the country level and the null hypothesis is that of no causal impact ($\lambda_{ji} \neq 0$).

Starting with the results of the Fixed Effects model, we observe that the null of no causal impact cannot be rejected for the GDP growth equation, while the null is rejected for the budget and productive expenditure equations, implying that these variables are caused by GDP growth. Our interpretation of these results is that the misspecified Fixed Effects model has led to non-stationary residuals, such that there is no long-run cointegrating relationship.

Turning to the results from the CCEP model, in the lower panel of Table A6, the null of no causal impact is rejected for the GDP growth equation, indicating that there is a long-run causal relation from the fiscal and conditioning variables to growth. The null of no causal impact cannot be rejected in the case of the budget, productive expenditure and distortionary taxation equations.

Overall, the weak exogeneity tests indicate that the empirical results based on the CCEP model can be interpreted as representing uni-directoral relationships from the fiscal (and conditioning) variables to GDP growth and *not* vice versa; as such, the results seem to not be driven by reverse causality.

Table A6: Canning and Pedroni (2008) tests for direction of causation

Model \ Variable		GDP growth	Labour force growth	Investment	Budget	Productive	Distortionary
FE	Avg λ	-0.352	0.146	0.625	0.361	0.297	-0.124
	p-val.	0.152	0.31	0.02*	0.019*	0.042*	0.75
CCEP	Avg λ	-0.88	-0.119	0.174	0.276	-0.015	-0.064
	p-val.	0.000*	0.539	0.027*	0.235	0.749	0.351

Note: FE - Fixed Effects estimator with time dummies, CCEP - Common Correlated Effects Pooled estimator.
Avg λ denotes the robust mean coefficient for the disequilibrium error term on the ECM.
The null hypothesis is that of no causal impact ($\lambda_i = 0$). An asterisk indicates the cases for which the null is rejected

sample. I present the results for the one-lag augmentation only and report that the inclusion of the second lag does not alter the results qualitatively