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ECONOMIC GROWTH AND INEQUALITY: THE ROLE OF FISCAL POLICIES*

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This paper examines the impact of different instruments of fiscal policy on economic growth and income inequality. We use an unbalanced panel of 43 upper-middle and high income countries for the period 1972–2006 to assess the incidence of different fiscal policies. The empirical results show that larger current expenditures and direct taxes diminish economic growth and reduce inequality, while increases on public investment reduces inequality without harming output. This suggests that the trade-off between efficiency and equity facing governments when designing their fiscal policies may be avoided.

I. Introduction

This paper investigates to what extent, and by means of which components, fiscal policy has an impact on economic activity and income inequality in a sample of 43 upper-middle and high income countries.

The interactions between economic growth and income inequality have attracted a great deal of attention in recent years. While earlier works suggested a negative *trade-off* between growth and inequality in the first stages of development, more recent studies suggest mechanisms by which inequality is indeed increased by economic growth or by which income inequality affects growth (positively or negatively).

Seminal studies by Lewis (1954), Kuznets (1955) and Kaldor (1956) suggested that income inequality is mostly determined by the level of economic development. More precisely, they analysed how economic development affects income distribution in the long-run suggesting a potential increasing effect of growth on income inequality in the first stages of economic development, and a decreasing effect in the later stages ('inverted-U hypothesis').[1] More recent studies have put forward new ideas about the effects of economic development on income inequality. These works have taken into account three phenomena: the rapid growth of international trade (Wood & Ridao-Cano, 1999); the increased diffusion of new technologies in different productive activities (Eicher, 1996; Galor & Tsiddon, 1997; Aghion *et al*., 1999; Hassler & Rodríguez-Mora, 2000), and the emergence of new organisational forms (Caroli, 2001).

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[1] For theoretical studies of this 'inverted-U hypothesis', see Robinson (1976), Greenwood and Jovanovic (1990) and Helpman (1998). In turn, Fields (2001) offers a complete survey of the empirical literature.

In contrast, in the extensive literature on development that has appeared during the 1990s, the causation between inequality and growth runs in the opposite direction. In fact, the central concern mainly focuses on the role of income and wealth inequality in the process of economic growth. Two main groups of studies can be identified in this theoretical literature. One group suggests various transmission channels through which greater initial inequality fosters economic growth.[2] The other group suggests several economic and political channels through which initial inequality might be harmful for growth.[3]

On the empirical side, the relationship between income inequality and economic growth has received considerable attention. This literature is largely based on cross-country regressions of economic growth and, to a lesser extent, on panel data econometrics. Whereas cross-country regressions are used to examine the relationship in the long-run showing a significant negative impact of inequality on growth,[4] panel data estimates aim at measuring the relationship in the short and medium-term and obtain mixed evidence.[5] In this sense, Banerjee and Duflo (2003) have argued that this diversity of results could be explained by the fact that most of the empirical studies estimate a linear model, whereas the true relationship may not be linear.

In a parallel strand of literature, the macroeconomic effects of fiscal policies on economic activity have been widely examined with contrasted views. Numerous works have used time series models, especially vector autoregressive models, to estimate the effects of different fiscal policy shocks on economic activity, but the issue of the sign and magnitude of these effects across different countries is very much an open question.[6] Other studies used a cross country approach to examine the impact of aggregate measures of fiscal policies on economic growth for an extensive sample of countries. However, in this approach, inspired by Easterly and Rebelo (1993), who used a panel data model adding fiscal variables in an *ad-hoc* manner to an empirical growth equation, the results are not particularly robust, showing that the impact and significance of the fiscal variables depend on the set of control variables included and also on the initial conditions of the economy.[7] Overall, no matter the approach, there is little consensus among economists as to the magnitude or even the sign of the effects of fiscal policies on economic growth.

The majority of these empirical studies use aggregate measures of fiscal policy to evaluate their impacts on economic activity and rarely take into account distributive issues.[8] The joint response of economic growth and income inequality to fiscal policies has been largely overlooked, with significant exceptions in recent papers that find a *trade-off* between some fiscal policies in terms of efficiency and equity (see García-Peñalosa & Turnovsky, 2007; Ramos & Roca-Sagalés, 2008).

The diversity of theoretical approaches that focus on the macroeconomic effects of fiscal policies; the shortage of empirical contributions examining their impacts for an extended set of

[2] See Rebelo (1991) and Deaton and Paxson (1997), among others.
[3] For studies that use purely economic reasons see, Aghion and Bolton (1992, 1997), Galor and Zeira (1993), Piketty (1997), Galor and Zang (1997), Murphy, Shleifer and Vishny (1989), and Mookherjee and Ray (2003). For studies that analyse the influence of political channels see Gupta (1990), Bértola (1993), Saint-Paul and Verdier (1993), Alesina and Rodrik (1994), and Bénabou (1996).
[4] See for example, Persson and Tabellini (1994) and Perotti (1994 and 1996).
[5] See Li and Zou (1998), Forbes (2000), Barro (2000), Lundberg and Squire (2003), Voitchovsky (2005); and, for more recent empirical contribution, see Lin *et al*. (2009), Huang *et al*. (2009) and Castelló-Climent (2010).
[6] Kamps (2005) and Perotti (2005) provide surveys of this literature.
[7] Similar results have been obtained by Koester and Kormendi (1989) and Mendoza *et al*. (1997).
[8] Only five out of twenty-seven macroeconometric investigations listed by Atkinson and Brandolini (2006) analysed the redistributive role of the state. Recently, Afonso *et al*. (2010) used Data Envelopment Analysis (DEA) to show the impact of social public spending and education performance on income distribution for developed OECD countries.

countries, and the scarcity of works that relate the growth and associated distributive effects to different public policies, points to the need for an analysis measuring both effects. In this context, our paper does the aforementioned and connects these two strands of literature.

To provide a comprehensive analysis of the growth and distributive effects of different fiscal instruments, we consider and estimate separately equations of growth and inequality using an unbalanced panel of 43 upper-middle and high income countries for the period 1972–2006. We begin by considering independent models of growth and inequality (orthogonal equations) that incorporate a limited set of control variables commonly found in the literature, and evaluate, independently, the impacts of different instruments of fiscal policy on both macro-aggregates. According to the above-mentioned literature, there are solid economic arguments to believe that income inequality and economic growth determine each other. Consequently, our empirical strategy also considers the inclusion of income inequality in the growth equation and GDP growth in the inequality equation (structural equations). This makes it possible to analyse the relationship between both aggregates and to investigate the role of fiscal policy, which has traditionally been considered as an effective instrument for generating revenue and for redistributive purposes.

The contribution of this paper is thus twofold. Firstly, we look simultaneously at GDP growth, income inequality and fiscal policies in an extended panel of countries. Secondly, we perform the analysis for a variety of disaggregated fiscal measures, both in terms of expense and revenue. This approach allows identifying the potential *trade-off* that governments confront between efficiency and equity when determining economic policy.

The results obtained show that fiscal policies have significant effects on growth and inequality. Higher direct taxes and current expenditures contract economic growth while, at the same time, reduce economic inequality. These results clearly reflect the *trade-off* between efficiency and equity that governments confront when designing their fiscal policies: increasing the size of the government diminishes economic growth, although it achieves a significant improvement in the equality of incomes. The only fiscal policy that may break this *trade-off* is public investment since, according to the results obtained; increases in this item reduce inequality without harming output.

This paper is organised as follows. Section II provides the theoretical framework, where different hypotheses concerning the influence of fiscal policies on economic growth and inequality are discussed. Section III details the data base and discusses the empirical methodology. In Section IV the empirical results are presented, while in Section V we test their robustness to different assumptions. Finally, Section VI contains our conclusions.

II. Theoretical Framework

In this section, we first present the theoretical priors underlying the empirical growth equations, in particular those related to the role of fiscal policies in economic activity; secondly, we present those that allow the impact of fiscal policies on economic inequality to be estimated; and lastly, we explain the fiscal variables considered in both models.

a) Fiscal policy and economic growth

The macroeconomic analysis distinguishes basically two general theoretical approaches when analysing the capacity of fiscal policy to affect economic activity. On the one hand, from a

neoclassical approach, several models emphasise the short-term effects of different instruments of fiscal policy. In this approach, the steady-state growth is driven by exogenous factors, such as the dynamics of population and the technological progress. Thus, the conventional wisdom has been that differences in tax and expenditure policies can be important determinants of the level of output, but are unlikely to have a significant permanent effect on the economic growth rate.[9]

The public-policy neoclassical growth models contrast with the predictions of the endogenous growth models, where growth is not conducted by exogenous factors. In these models, investment in human and physical capital does affect the steady-state growth rate and, consequently, there is much more scope for tax and government expenditure to play a role in the growth process. These works tend to transform the temporary growth effects of fiscal policy that the neoclassical model involves, into permanent effects. Thus, endogenous growth models that incorporate public policies predict that distorting taxes, as well as productive public expenditures, affect economic growth. It follows that fiscal policy can affect the level of output as well as its long-term growth rate.[10]

In line with these endogenous approaches, our benchmark equation of economic growth is based on the models developed by Barro (1990) and Barro and Sala-i-Martin (1992). Additionally, and in order to avoid the biases associated with an incomplete specification of the government budget constraint, we follow Kneller *et al*.'s (1999) strategy concerning the inclusion of fiscal variables.

We consider an economy of n producers, each one producing one product (y), according to the production function:

$$y = Ak^{1-\alpha}g^{\alpha} \tag{1}$$

where k represents private capital and g the public capital used by the producer (what we consider the productive public expenditure).

The government balances its budget in each period by raising a proportional tax on output at rate τ (distortionary tax) and lump-sum taxes L. Therefore, the budget constraint that the government faces can be expressed as:

$$ng + C + b = L + \tau ny \tag{2}$$

where C and g are the non-productive and productive public expenditure, respectively. Because we allow for the case of an unbalanced budget, we include a variable b that collects the budgetary surplus (deficit).

The economic growth rate of the country i during period t, $\Delta y_{i,t}$ is a function of a set of non-fiscal variables $X_{i,t}$ and a vector of fiscal variables $FP_{i,t}$:

$$\Delta y_{i,t} = \alpha + \beta \sum_{h=1}^{n} X_{i,t}^{h} + \sum_{j=1}^{m} \gamma_j FP_{i,t}^{j} + u_{i,t} \tag{3}$$

Assuming that vector FP includes all the relevant elements, we deduce that:

$$\sum_{j=1}^{m} FP_{i,t}^{j} = 0 \tag{4}$$

[9] Sato (1967), Krzyzaniak (1967) and Feldstein (1974) use the neoclassical model to analyse the effects of different taxes on growth; Chamely (1986) and Judd (1985) use the model developed by Cass (1965) and Koopmans (1965) to study the effects of fiscal policy considering endogenous saving rates; Summers (1981) and Auerbach and Kotlikoff (1987) adapt the model of overlapping generations of Diamond (1965) to analyse the dynamic effects of fiscal policy.

[10] Since the pioneering contributions of Barro (1990), King and Rebelo (1990) and Lucas (1990), several papers have extended the analysis of taxation, public expenditure and growth. See, for example, García-Peñalosa and Turnovsky (2007).

In order to avoid perfect collinearity in the estimation of equation (3) we exclude one element of vector *FP*. The omitted variable is effectively the assumed compensating element within the government's budget constraint (Kneller *et al*., 1999). Thus, considering that the growth equation can be expressed as:

$$\Delta y_{i,t} = \alpha + \beta \sum_{h=1}^{n} X_{i,t}^{h} + \sum_{j=1}^{m-1} \gamma_j FP_{i,t}^{j} + \gamma_m FP_{i,t}^{m} + u_{i,t} \tag{5}$$

we omit the element $FP_{i,t}^{m}$ to obtain the new growth equation:

$$\Delta y_{i,t} = \alpha + \beta \sum_{h=1}^{n} X_{i,t}^{h} + \sum_{j=1}^{m-1} (\gamma_j - \gamma_m) FP_{i,t}^{j} + u_{i,t} \tag{6}$$

According to this strategy, the interpretation of the estimated coefficient of each fiscal variable is the effect of a unitary change in the relevant variable (included in the regression) *offset* by a unitary change in the omitted fiscal variable, which is the implicit financial element. The interpretation of the estimated coefficients of the non-omitted fiscal variables varies if the omitted category is altered.

In order to reduce the specification error bias, we consider two growth orthogonal equations containing different sets of control variables. Model 1 considers a set of control variables based on the Solow growth model that includes the initial level of GDP *per capita*, private investment, and population growth. Based on Mankiw, Romer and Weil (1992), and in order to control for the impact of human capital accumulation, Model 2 includes the former Solow set and incorporates the average years of schooling of the population aged 25 and above.

Previous studies do not take into account inequality when calculating the effects of fiscal policy on output. As argued above, we also consider the inclusion of an inequality measure in the growth equations allowing for a joint analysis of the macroeconomic and distributive effects of fiscal policy, which constitutes a novel feature of our study. Thus, Model 3 and 4 (structural equations) expand our benchmark growth equations with the addition of an inequality variable (*Gini* index) in Model 1 and 2, respectively.

b) Fiscal policy and income redistribution

In contrast with the abundant theoretical literature relating fiscal policy and economic growth, contributions about the effects of such policies on income inequality have been very scarce until recently.

For economic inequality, our benchmark equation is based on the empirical approaches of Li and Zou (1998), Li, Squire and Zou (1998), Castelló and Doménech (2002) and Lundberg and Squire (2003). The fiscal policy variables are incorporated following the same strategy used for the growth equation that excludes one of the elements of vector FP. Thus, the performance of income inequality depends on two sets of non fiscal (*Z* vector) and fiscal (*FP* vector) variables:

$$Ineq_{i,t} = \delta + \psi \sum_{k=1}^{l} Y_{i,t}^{k} + \sum_{j=1}^{m-1} (\xi_j - \xi_m) FP_{i,t}^{j} + \varepsilon_{i,t} \tag{7}$$

In line with the aforementioned literature, controls for the inequality equation should take into account a measure of civil liberties, and a measure of educational inequality as a proxy of assets inequality. This first measure allows consideration for the political control of the richest segment of society and their influence on income distribution, given their political ability to protect their wealth. On the other hand, the inclusion of an educational inequality variable allows us to measure

the importance of the distribution of human capital in explaining differences in income inequality.[11] Finally, the FP vector contains the fiscal variables, omitting the variable which we assume as the compensating element within the government's budget constraint.

In order to reduce the specification error bias, we consider two inequality orthogonal equations, Models 5 and 6, the only difference being that the last also includes a dummy variable that controls for the difference in the construction of the inequality variable (the value is one if the income inequality measure is calculated from an income concept net of taxes and zero otherwise). The correspondent part of this strategy consists of the inclusion of economic growth in these inequality models, which constitutes our inequality structural equations (Models 7 and 8).

c) Fiscal policy variables aggregation

We classify taxes as distorting or not distorting, depending on whether they do or do not affect labour and investment decisions of agents creating tax wedges and hence distorting the steady-state rate of growth. Similarly, we classify public expenses as productive or non productive, depending on whether they are or are not included as arguments in the private production function (when classified as productive, public expenses might have a positive direct effect on the growth rate).

In the case of the present study, the existing limitations concerning the availability of homogenous country fiscal data provided by the *Government Finance Statistics of the International Monetary Fund* (*GFS-IMF*), forced us to consider a set of seven fiscal variables that cover almost 100 per cent of the total public revenues and expenses (see column 1 of Table I).[12]

Following the categories listed on Table I, we consider, firstly, direct taxes as being equivalent to distortionary taxes while indirect taxes are equivalent to non-distortionary taxes;[13] and secondly, public current expenditure is equivalent to unproductive expenses while public investment is equivalent to productive expenses. To these four relevant fiscal variables, we add the government budget surplus/deficit, revenues whose classification is ambiguous (we label these 'other revenues'), and finally, net lending (including net transactions in financial assets and liabilities).

III. Database and Empirical Methodology

a) Database[14]

We construct a panel data for an extended set of 43 countries catalogued as high-income or upper-middle-income by the World Bank. The selection of countries was determined by two important factors. Firstly, in line with Fölster and Henrekson (1999) and Castelló-Climent (2010), we consider that the empirical analysis of the relationships between growth, inequality and size of

[11] It is important to note that this measure of education refers to the quantity of schooling, and does not take into account the quality of the education system (see Castelló & Doménech, 2002; Castelló-Climent, 2010).
[12] We have not included social security contributions in government revenues due to distorting effects on growth equation.
[13] In other endogenous growth models, like Mendoza *et al*. (1997), consumption taxation becomes distortionary, with a negative effect on growth if leisure is included in the utility function, affecting education/labour-leisure choices and thus capital/labour ratios in production.
[14] Appendix A provides the definition of all used variables, Appendix B the summary statistics, and Appendix C the list of the countries included.

Table I Theoretical aggregation of fiscal policy

Theoretical classification	*Government finance statistics classification*
Direct taxes	• Taxes on income, profits, and capital gains
	• Taxes on payroll and workforce
	• Taxes on property
Indirect taxes	• Taxes on goods and services
	• Taxes on international trade and transactions
Other revenues	• Other taxes
	• Grants
	• Other revenue
Current public expenditure	• Compensation of employees
	• Use of goods and services
	• Consumption of fixed capital
	• Interest
	• Subsidies
	• Grants
	• Social benefits
	• Other expense
Public investment	• Net acquisition of non financial assets
Transactions in financial assets and liabilities	• Net acquisition of financial assets
	• Net incurrence of liabilities
Government surplus/deficit	• Total revenues minus total outlays

Notes: The classification is based on the manual *GFS 2001* and corresponds to the general government.

the government should be restricted to countries with similar wealth ranges. Secondly, we consider the availability, frequency, quality and comparability of long data series. The panel is unbalanced using five-year average data; it covers the period 1972–2006, and contains harmonised economic, political and social data obtained from different sources.

Economic variables, related to the product and investment, are taken from Penn World Table 6.1. Variables concerning fiscal policies are taken from the Government Finance Statistics of the International Monetary Fund (GFS-IMF). The human capital variables are obtained from Barro and Lee (2001); while the Gini index of education is obtained from Castelló and Doménech (2002). Finally, institutional variables are taken from Freedom House.

Since we analyse the impact of government taxes and expenses on economic inequality, we use as a measure of inequality, the *Gini* coefficient calculated with respect to the household disposable equivalent income and/or consumption, covering the entire population of the analysed economy. Thus, the variables related to income inequality are taken from *UNU-WIDER version 2b*.[15] In order to build a homogeneous and comparable inequality data base, we select and adjust the available observations according to the following criteria. Firstly, low quality observations are eliminated (quality '4' and '3', the minor values in the ranking). Secondly, for each country we only consider data coming from the same source and survey. Thirdly, in order to maximise the sample, we consider household equivalent disposable income as well as consumption by the whole population of the country (the coverage had to be representative of the national population); in addition, all uses of consumption had to be accounted for, including own-consumption. And finally, each country should have a minimum of three observations (with a maximum of seven for the period 1972–2006).

[15] This database consists of a checked and corrected version of the World Income Inequality database (WIID version 1), which in turn considers an update of the Deininger and Squire (1996) database, and new estimates from the Luxembourg Income Study and Transmonee databases.

b) Empirical methodology

We consider five-year averages of all variables for different reasons. Firstly, because we did not expect year-to-year changes in fiscal policy variables affect yearly changes in economic growth and inequality. Secondly, taking five-year averages will reduce the short-run fluctuations and therefore the influence of the economic cycle, allowing us to focus on the structural relationship that is of interest to us. Thirdly, by using five-year means, we partially compensate for the limited availability of annual country inequality data, allowing a more balanced data set to be considered. Although for most of the variables we have yearly observations, our data on *Gini* coefficients are more limited – many countries have less than ten observations, whereas only a few countries have more than twenty annual observations. Because our aggregate measures of inequality are relatively stable over time, five-year averages will not result in much loss of information.[16]

In the empirical estimations we consider five different forms of panel data estimator for each regression: pooled OLS, one-way (country dummies) fixed effects (by OLS) and random effects (by GLS), and two-way (country and time effects) fixed and random effects models. We select the model specification based on both theoretical and statistical reasons. Thus, in case of growth equation, we have considered the two-way fixed effects (FE) estimator to deal with one of the major potential problems which is omitted variable bias. This enables us to control for cross-country heterogeneity as well as period-specific factors common to all cross-section units. Among other things, the unobserved country-specific effects may reflect differences in the initial level of efficiency, whilst the period-specific intercepts pick up productivity changes that are common to all countries. On the empirical side, the results of the *Hausman test* reject the null hypothesis of no correlation between the individual effects and the error term, showing the convenience of estimating a fixed effects model. According to these criteria and the value of the log-likelihood function and the adjusted R^2, the growth equations (Models 1 to 4) are estimated through a two-way fixed effects model.

In relation to the inequality equation, we should point to two important aspects concerning the economic inequality variable used (*Gini* index). Firstly, this variable is relatively stable within countries during the analysed period; and, secondly, it changes significantly between countries (see Appendix B). Therefore, the statistical primary results offer sufficient evidence that inequality is determined by factors that differ substantially between countries though they tend to be relatively stable inside the same ones, pointing that differences across countries may have an important influence on our income inequality measure.[17] Thus, in the inequality equations (Models 5 to 8), considering a fixed effects model which ignores the between country variation and imposes too many restrictions was not viewed as the most adequate empirical strategy (see Baltagi, 2008, chs 2 and 3). The most appropriate specification taking into account the aforementioned criteria and the value of the log-likelihood function and the adjusted R^2, is a one-way random effects model using temporal dummies which considers within and cross country comparisons in the estimation.[18]

[16] Examples that have used the same procedure are Li and Zou (1998), Li, Squire and Zou (1998), Forbes (2000), Li, Xu, and Zou (2000), Lundberg and Squire (2003) and Barro (2008), among others.
[17] An analysis of the variance components (ANOVA) of the *Gini* coefficients shows that, for the entire sample, 91.8 per cent of the variance is cross-country.
[18] In fact, the GLS estimator of a random effects model is a matrix weighted average of within and between estimators weighing each estimate by the inverse of its corresponding variance (see Baltagi, 2008, pp. 19–20).

IV. Empirical Results

In this section we present the estimations of the different model specifications with respect to the impact of public expenditures and taxes on economic growth and also the effects of such fiscal policies on income inequality.

a) The effects of fiscal policy on growth

Table II summarises the results of the empirical growth models considering no relation between growth and inequality (orthogonal equations), and allowing for the influence of inequality on economic growth (structural equations). In each model, we consider first indirect taxes, and second direct taxes, as the implicit financing element. Finally, we only report the estimates of relevant and significant fiscal variables (other revenues, net lending, and the surplus/deficit variables are neither statistically nor economically significant).

A first noteworthy result is that the estimations of the orthogonal and structural equations are very similar; none of the control and fiscal policy variables present significant changes between both types of equations.

We begin by discussing the results concerning the control variables. We find that initial GDP enters into the regressions with a significant negative coefficient, indicating a conditional convergence of growth rates over the period; this result is in line with those obtained by Barro (1991, 2008), Kneller *et al*. (1999) and Castelló-Climent (2010), but contradicts Easterly and Rebelo (1993). Private investment has a significant and positive effect on growth; a result that differs with that obtained by Kneller *et al*. (1999), where a measure of the total investment (private and public) is considered and found to be not significant, possibly reflecting problems of collinearity with the measures of fiscal policy that include public investment.[19] Population growth, as in Lin *et al*. (2009), is significant and presents the expected negative sign, something which again contrasts with the non significant coefficient that, using the workforce growth variable, Kneller *et al*. (1999) obtain. Finally, as in Barro (1991), the initial stock of human capital is significant and positively related to economic growth.

The signs of the relevant fiscal variables are consistent with theory. Thus, current expenditure has a negative and significant impact on GDP growth, regardless of whether it is financed by direct or indirect taxes; however, this negative impact is greater when the implicit financing elements are direct taxes. This negative coefficient, which was also obtained by Barro (1990 and 2008) and Castelló-Climent (2010), can be interpreted in several ways. Firstly, it is possible that part of that government spending is somehow wasteful. Secondly, it is also possible that government spending is just a proxy for the entire set of government non-price interventions (like employment legislation, health and safety rules and product standards), and, it may be that these non-price interventions are responsible for reducing growth, and not the level of expenditure.

Public investment is positive and with a smaller coefficient than private investment but it is not statistically significant, regardless of whether it is financed by direct or indirect taxes. Considering that public investment is constituted mainly by investment in infrastructures, one would expect that it influences the rate of economic growth both positively and directly. According to this argument, our result would be somehow surprising; however, as Romp and Haan (2007) and

[19] For studies that find a positive and significant coefficient of total investment to GDP ratio on growth, see, for example, Voitchovsky (2005) and Lin *et al*. (2009), among others.

Table II Economic growth. Dependent variable: log of real GDP *per capita* growth

	Orthogonal equations				*Structural equations*			
	Model 1		*Model 2*		*Model 3*		*Model 4*	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Omitted fiscal policy variable:	*Indirect taxes*	*Direct taxes*	*Indirect taxes*	*Direct taxes*	*Indirect taxes*	*Direct taxes*	*Indirect taxes*	*Direct taxes*
Initial GDP %	−1.0068***	−1.0269***	−0.7890***	−0.7820***	−0.8578***	−1.0211***	−0.9463***	−1.0618***
Inequality	–	–	–	–	−1.2839***	−0.9973***	−1.0910**	−0.9074**
Private investment	0.5296***	0.4378***	0.4606***	0.3203***	0.7348***	0.6470***	0.6091***	0.4652*
Population growth	−0.0433*	−0.0254	−0.1428***	−0.1264***	−0.1604***	−0.1172***	−0.1863***	−0.1578***
Human capital	–	–	0.4394*	0.3611**	–	–	0.3853**	0.2921
Public investment	0.1771*	0.1726*	0.1541	0.1090	0.1981	0.2044	0.2092	0.2218
Current public expense	−0.5338***	−0.9041***	−0.7688***	−0.9651***	−0.7274***	−1.0343***	−0.8462***	−1.1028***
Direct taxes	−0.3951***	Omitted	−0.4162***	Omitted	−0.5112***	Omitted	−0.4204**	Omitted
Indirect taxes	Omitted	0.2256	Omitted	0.0121	Omitted	0.0911	Omitted	0.0314
Adjusted R- squared	*0.60*	*0.59*	*0.57*	*0.54*	*0.60*	*0.55*	*0.58*	*0.53*
No. of observations	*149*	*146*	*130*	*128*	*117*	*114*	*104*	*102*
No. of countries	*43*	*43*	*35*	*35*	*41*	*41*	*33*	*33*

Notes: Estimation technique: two-way fixed effects model. All explanatory variables are expressed in five-year averages and in logs, except population growth. * significant at 10% level; ** significant at 5%, *** significant at 1%.

Kamps (2005) summarise, this positive but non-significant impact could be explained because the effect of public investment may differ considerably across the countries included in our sample.

A significant negative effect is found in the case of direct taxes. This result, which is also obtained by Kneller *et al*. (1999), is consistent with economic theory because of the distorting effects of this type of taxes. In contrast, indirect taxes do not have a significant impact on growth.

An important additional result derived from the structural equations is that income inequality, measured by the Gini coefficient, harms economic growth.[20] This result is consistent with the early 1990s empirical growth literature based on a cross-country approach (see Persson & Tabellini, 1994; Perotti, 1994, 1996), and also with more recent studies that use a panel data approach (Huang *et al*., 2009). However, the negative effect of inequality on growth is contradictory with the conventional textbook indicating that inequality is good for incentives and therefore good for growth,[21] and also differs from the empirical studies of Partridge (1997), Li and Zou (1998), Forbes (2000), Barro (2000), Lundberg and Squire (2003), and Castelló-Climent (2010). Despite the fact that these latter papers also use a panel data approach, it is important to underline that the sets of control variables, countries and period considered are different.

Given that in this empirical model we are considering fiscal policy variables, we think that the significant and negative impact of inequality on growth cannot be explained only by the traditional arguments based on the political economy literature (see Alesina & Rodrik 1994; Bénabou, 1996; among others). Additionally, given that we also control for investment (in human and physical capital), this result would indicate that income inequality has a direct negative effect on growth not coming from its effect on these investment decisions.[22] In a context of upper-middle and high income economies, and considering that capital markets are imperfect and the agents are heterogeneous, one possible explanation could arise to explain the estimated negative effects of inequality on growth. Inequality is detrimental to growth, as borrowers tend to under-invest in effort when it is unobservable; when there are incentive problems, the more unequal the income distribution is, the lower the aggregate level of effort will be (see, for example, Aghion and Bolton (1997)).

b) Distributional effects of fiscal policy

The inequality equations allow the distributive effects of fiscal policies to be analysed. In Table III we present the main results obtained with the orthogonal and structural equations of inequality detailed in Section IIb. In each model, the first column shows the results considering indirect taxes as the implicit financing element, while the second column uses direct taxes. We only report the estimates of the relevant fiscal variables (other revenues, net lending, and the surplus/deficit variables are neither statistically nor economically significant).

The results of the orthogonal and structural equations are very similar and do not change in terms of significance, sign and magnitude of the control variables. In both types of equations, the control variables are significant and with the expected sign, which basically coincides with the

[20] To reduce any inconsistency resulting from the fact that some Gini coefficients are based on income, whereas a few are based on expenditure, in these structural equations we follow Deininger and Squire's suggestion and add 6.6 points to Gini coefficients based on expenditure.
[21] The traditional visions propose a positive effect of inequality on growth due to different rates of saving of rich and poor individuals, investment indivisibilities, and due to incentive effects.
[22] For works that analyse the role of investment to explain a negative impact of inequality on growth, see Banerjee and Newman (1993) and Piketty (1997).

Table III Income inequality. Dependent variable: log of Gini Index

	Orthogonal equations				*Structural equations*			
	Model 5		*Model 6*		*Model 7*		*Model 8*	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Omitted fiscal policy variable:	*Indirect taxes*	*Direct taxes*	*Indirect taxes*	*Direct taxes*	*Indirect taxes*	*Direct taxes*	*Indirect taxes*	*Direct taxes*
Civil liberties	0.0427**	0.0510**	0.0484**	0.0558***	0.0673***	0.0562**	0.0756***	0.0564**
Education inequality	0.1056**	0.1080**	0.1026**	0.1042**	0.0812*	0.1035**	0.0784	0.1014**
Growth	–	–	–	–	−0.0170*	−0.0139	−0.0162*	−0.0128
Public investment	−0.0414	−0.0634***	−0.0525*	−0.0692**	−0.0450	−0.0680*	−0.0604**	−0.0778**
Current public expense	−0.1974***	−0.2948***	−0.2555***	−0.3320***	−0.2318***	−0.3113***	−0.3262***	−0.3811***
Direct taxes	−0.0857***	Omitted	−0.0702**	Omitted	−0.0680*	Omitted	−0.0385*	Omitted
Indirect taxes	Omitted	0.0510	Omitted	0.0410	Omitted	0.0672	Omitted	0.0539
Disposable income dummy	–	–	0.0780*	0.0827*	–	–	0.0935**	0.0960**
Adjusted R- squared	*0.57*	*0.55*	*0.63*	*0.63*	*0.55*	*0.52*	*0.65*	*0.63*
No. of observations	*130*	*128*	*110*	*109*	*101*	*100*	*101*	*100*
No. of countries	*35*	*35*	*35*	*35*	*34*	*34*	*34*	*34*

Notes: Estimation technique: random effects model with temporal dummies. All variables are expressed in five-year averages and in logs, except disposable income dummy variable. * significant at 10% level; ** significant at 5%, *** significant at 1%.

results of Li and Zou (1998), and Li *et al*. (1998). Thus, increases in initial civil liberties index reduce income inequality while an increase in initial educational inequality increases income inequality. It is also important to emphasise that the dummy variable that controls for the differences caused by the different source of the *Gini* indices, which is incorporated in Model 6 and 8, is significant and increases the explanatory power of both types of equations (orthogonal and structural).

Concerning the fiscal variables, it is noteworthy that current public expenditure has a significant and sizeable negative effect on income inequality; it reduces income inequality regardless of whether it is financed by direct or indirect taxes. This result is consistent with Bulir and Gulde (1995), Gustafsson and Johansson (1999), Li *et al*. (2000), Galli and van der Hoeven (2001), and Afonso *et al*. (2010). One would expect that this type of expenditure reduces income inequality because it includes different social expenses with distributive implications through the immediate benefits, for example, expenses in transfers like pensions or different subsidies.

The effect of public investment on inequality is slight and not statistically significant in the orthogonal equations. However, the effect of this variable is negative and statistically significant in the structural regressions. This latter result showing a reduction in inequality is in line with the arguments of Brenneman and Kerf (2002) and with the empirical results obtained by Calderón and Servén (2004). Conceptually, the development of public infrastructures helps underdeveloped areas of the economy to be connected to the cores of economic activity, allowing access to additional productive opportunities. Another argument along these lines is that infrastructures also improve access to help and education services.

The effect of direct taxes on inequality is negative and significant; nevertheless, the estimated coefficients are much smaller than those corresponding to current expenditure. This negative impact may reflect the progressive structure of the tax systems of the analysed countries, many of them with a modern fiscal system. With a progressive tax system, increases in direct tax revenue – whether through increases in the tax base, in the overall average tax rate or in the progression of the tax structure – would yield a larger redistributive effect and thus lower inequality (Lambert, 2001). Finally, indirect taxes have a positive coefficient but not significant.

Lastly, the results obtained with the structural equations show that economic growth has a statistically significant and negative effect on inequality.

V. Sensitivity Analysis

In this section we test the robustness of our main results by modifying some aspects of the estimated growth and inequality equations. In both cases, we begin by testing if the coefficients of the fiscal variables are sensitive to the inclusion of new control variables in both equations.

Secondly, we estimate a dynamic panel data model in both equations that takes into account the persistency of dependent variables. Methodologically, we use the system GMM estimator (for example, Blundell & Bond, 1998, 2000; Blundell, Bond & Windmeijer, 2000) that controls for country-specific effects and also takes into account the persistence of the explanatory variables. In turn, as a way of dealing with endogeneity, we consider explanatory variables (including fiscal variables) at the beginning of each five-year period.[23]

[23] We consider all these explanatory variables as predetermined. An example of the same empirical methodology is, for example, Forbes (2000).

Thirdly, we perform an additional sensitivity test for each equation. In the case of growth, we consider a random effects model with temporal dummies in order to check the influence of assuming country specific effects on our main results. In the case of inequality, we consider an instrumental variables method (IV) via two-stage least squares in order to deal with potential endogeneity.

Finally, in order to fathom whether the results are being driven by one particular country in our sample, we repeat the regressions of growth and inequality after removing each of the countries one at time. The results, in both equations, are stable indicating that no single country is driving our results.

a) Sensitivity analysis I: The growth equations

Table IV reports the results of the three sensitivity analysis of growth equation. In a first instance, we conduct a stepwise regression analysis by adding other variables discussed in the growth literature on Model 2 and 4 (those that also include a human capital variable). The works of Barro (1990), Mendoza *et al*. (1997) and Lundberg and Squire (2003), provide the new variables considered in this sensitivity analysis which are trade, inflation, financial development, and a measure of civil liberties. We report the results including only the variables that are significant (trade and inflation).[24] Columns 1 to 4 report the results of this sensitivity exercise. Additionally, and following Banerjee and Duflo (2003), we have also tested a quadratic relationship between economic growth and inequality, but the results unambiguously show that is not the case.[25]

In our second sensitivity analysis, we consider a dynamic growth equation by system GMM estimator that controls for country-specific effects and also takes into account the persistence of the explanatory variables, as is the case of income inequality in our structural growth equation.[26] The developments in dynamic panel data models have focused mainly on those applications to micro data sets, which generally have a large cross-section dimension but a limited time series dimension (large N, small T). These properties also typically match the dimensions of our data based on five-year average (N around 43, T around 7).

Finally, in order to check how sensitive the results are to the country fixed effects assumption, we also perform a one-way random effects model using temporal dummies, which is the same empirical approach we have used in the inequality main equations (see Models 6 and 8 in Table III).

Throughout this sensitivity analysis, three main results clearly emerge. Firstly, the inclusion of new variables is not responsible for the strong fiscal effects identified earlier; the significance of the fiscal variables is not sensitive to the inclusion of these macro variables. Two of the new variables considered are significant and with the expected sign showing that international trade raises economic growth while inflation reduces it; both results were also found by Mendoza *et al*. (1997) and Barro (1990); and Castelló-Climent (2010) respectively. Secondly, if we look at the results in Table IV of the dynamic models (columns 5 to 8), we observe that the coefficients, signs and significance of all the relevant fiscal variables remain unchanged confirming the effects

[24] The significance and signs of the relevant fiscal variables remain unchanged including all new control variables.
[25] These results are not presented and are available upon request.
[26] For the use of system GMM estimator in growth equations see, for example, Bond *et al*. (2001), Dollar and Kraay (2002), Voitchovsky (2005) and Castelló-Climent (2010).

Table IV Sensitivity analysis I. Economic growth – dependent variable: log of real GDP *per capita* growth

	More control variables on Model 2 and 4 (I)				*Dynamics on Model 2 and 4 (II)*				*Random Effects Model on Model 2 and 4 (III)*			
	Orthogonal equations		*Structural equations*		*Orthogonal equations*		*Structural equations*		*Orthogonal equations*		*Structural equations*	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
Omitted fiscal policy variable:	*Indirect taxes*	*Direct taxes*	*Indirect taxes*	*Direct taxes*	*Indirect taxes*	*Direct taxes*	*Indirect taxes*	*Direct taxes*	*Indirect taxes*	*Direct taxes*	*Indirect taxes*	*Direct taxes*
Initial GDP %	−0.7236***	−0.7691***	−0.7799**	−0.8507**	–	–	–	–	−0.3320***	−0.3252***	−0.7236***	−0.7691***
GDP % growth (*t*-1)	–	–	–	–	−0.1395***	−0.0991*	−0.2093**	−0.3413***	–	–	–	–
Inequality	–	–	−0.2874	−0.1207	–	–	−1.1021**	−1.4949*	–	–	–	–
Private investment	0.3193**	0.2182	0.4174	0.2515	0.3373***	0.3192**	0.0167	0.0705	0.4730***	0.4749***	0.3193**	0.2182
Population growth	−0.1501***	−0.1246***	−0.1883***	−0.1421***	−0.1882***	−0.1502***	−0.1590	−0.1503	−0.1207***	−0.1027***	−0.1501***	−0.1246***
Inflation	−0.1793***	−0.1818***	−0.0558*	−0.1188***	–	–	–	–	–	–	−0.1793***	−0.1818***
International trade	0.5732***	0.6579***	0.4613*	0.6174*	–	–	–	–	–	–	0.5732***	0.6579***
Human capital	0.3975*	0.2931	0.2747	0.1100	0.0784	0.1015	−0.0288	−0.0926	0.2732**	0.3149***	0.3975*	0.2931
Public investment	0.1371	0.1163	0.1492	0.1271	0.0636	−0.1874	−0.0800	−0.3139	0.1100	−0.1463	0.1371	0.1163
Current public expense	−0.9713***	−1.2073***	−0.9252***	−1.2240***	−0.5692**	−1.2105***	−0.5001**	−1.2097**	−0.7082**	−1.2365**	−0.9713***	−1.2073***
Direct taxes	−0.4529***	Omitted	−0.3823**	Omitted	−0.4319**	Omitted	−0.227*	Omitted	−0.3295***	Omitted	−0.4529***	Omitted
Indirect taxes	Omitted	0.0292	Omitted	0.0649	Omitted	0.3654	Omitted	0.4297	Omitted	0.2655	Omitted	0.0292
Adjusted R- squared	0.63	0.60	0.55	0.52	–	–	–	–	0.43	0.41	0.35	0.32
AR(1)	–	–	–	–	0.076	0.035	0.049	0.056	–	–	–	–
AR(2)	–	–	–	–	0.333	0.271	0.591	0.332	–	–	–	–
Sargan test	–	–	–	–	0.004	0.008	0.021	0.058	–	–	–	–
Hansen Test	–	–	–	–	0.737	0.688	0.940	0.997	–	–	–	–
No. of observations	121	119	97	95	95	93	71	69	130	128	104	102
No. of countries	33	33	31	31	35	35	33	33	35	35	33	33

Notes: Estimation techniques: (I) two way fixed effects model; (II) two- step System GMM with small-sample adjustment and orthogonal deviation; (III) random effects model with temporal dummies. All variables are expressed in five-year averages and in logs except population growth. * significant at 10% level; ** significant at 5%, *** significant at 1%.

identified earlier. Therefore, the interpretation of the role of key fiscal variables on growth is substantially unaffected: increasing the size of government (through current expenditure and direct taxes) reduces economic growth while an increase in inequality reduces economic growth. Finally, in the case of the random effects models, which also considers cross-countries comparisons, no substantial changes are detected confirming the robustness of the effects identified earlier (see columns 9–12 of Table IV).

b) Sensitivity Analysis II: The inequality equations

In the case of the inequality equations, we proceed with a similar strategy to that employed in the growth equations. In first instance, we conduct a stepwise regression analysis by adding other control variables discussed in the inequality literature. Thus, the selection of the additional variables to include (inflation, private investment, trade and initial GDP), is based on the contributions of Li, Squire and Zou (1998) and Li *et al*. (2000).

In a second instance, as in the case of the growth equation, we do consider a dynamic equation estimated by system GMM, as a strategy to take into account the persistent characteristics of inequality (see columns 5 to 8, Table V).

Finally, since our main concern is endogeneity, which is constantly raised in income distribution literature (see, for example, Li and Zou (1998)), we apply the instrumental variables method (IV) via two-stage least squares to correct for the endogeneity of the fiscal variables. In this case, we deal with endogeneity by using the five-year lagged values of our endogenous explanatory variables as instruments. The use of five-year lagged values as instruments is justified for three reasons (Murray, 2006). Firstly, it is unlikely that inequality will today affect past values of our fiscal policy variables. Secondly, the lagged values of these variables are correlated with the values without lags. Lastly, the only impact of these lagged values on inequality must pass through the endogenous variables. This is suggested by the fact that including the explanatory endogenous variables and their five-year lagged values in the same regression yields no statistically significant effect of the latter.

Table V reports the results of this three sensitivity analysis applied to the inequality equations. In columns 1 to 4, we show the results adding the trade variable to the orthogonal and structural inequality equations corresponding to Models 6 and 8 (trade is the only additional variable which turns out to be significant at least in some of the new regressions).[27] In columns 5 to 8, we present the results considering a dynamic inequality equation estimated by system GMM. Finally, in columns 9 to 12 we present the instrumental variables (IV) estimation results of both inequality equations when the five-year lagged values of the independent variables are used as a set of instruments, since there is usually no correlation between the disturbance and the lagged values (see Iimi, 2005; Enikolopov & Zhuravskaya, 2007).

Two main results emerge clearly from Table V. Firstly, throughout the sensitivity analysis, public current expenditure and direct taxes remain significant and the estimated coefficients are similar to those of the original regressions on Table III; therefore these results appear to be quite robust to the inclusion of new variables, to the estimation of a dynamic inequality equation and to instrumental variables (IV) estimation via two-stage least squares. Secondly, we also observe that public investment has a significant impact on inequality. Hence, we confirm the

[27] The inclusion of additional not significant variables did not change the significance and sign of fiscal variables.

Table V Sensitivity analysis II. Income inequality. Dependent variable: log of Gini Index

	More control variables on Model 6 and 8 (I)				*Dynamics on Model 6 and 8 (II)*				*Instrumental variables on Model 6 and 8 (III)*			
	Orthogonal equations		*Structural equations*		*Orthogonal equations*		*Structural equations*		*Orthogonal equations*		*Structural equations*	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
Omitted fiscal policy variable:	*Indirect taxes*	*Direct taxes*	*Indirect taxes*	*Direct taxes*	*Indirect taxes*	*Direct taxes*	*Indirect taxes*	*Direct taxes*	*Indirect taxes*	*Direct taxes*	*Indirect taxes*	*Direct taxes*
Inequality ($t-1$)	–	–	–	–	0.6166***	0.5929***	0.3889**	0.4381**	–	–	–	–
Civil liberties	0.0499*	0.0553*	0.0731**	0.0585*	0.0542***	0.0354*	0.0887***	0.0704**	0.0938*	0.0250	0.0644	0.0466
Education inequality	0.0985**	0.1129**	0.0733*	0.0993*	–0.0101	0.0322	0.0278	0.0003	0.0856	0.1934**	0.1010	0.1568
Growth	–	–	–0.0114	–0.0083	–	–	–0.0198*	–0.0225*	–	–	–0.0090	–0.0106
Public investment	–0.0530	–0.0854***	–0.0647*	–0.1043***	–0.0001	–0.0112*	–0.0252**	–0.0165**	–0.0318**	–0.0429**	–0.0268*	–0.0445
Current public expense	–0.2394***	–0.3465***	–0.3180***	–0.4176***	–0.1465***	–0.1143***	–0.1369***	–0.2054***	–0.4571***	–0.5365***	–0.4483***	–0.6204***
Direct taxes	–0.0738**	Omitted	–0.0452*	Omitted	–0.045**	Omitted	–0.0232**	Omitted	–0.0583***	Omitted	–0.0619**	Omitted
Indirect taxes	Omitted	0.0823**	Omitted	0.0956**	Omitted	–0.0366	Omitted	0.0062	Omitted	0.0385	Omitted	0.1176
International trade	–0.0658*	–0.0953**	–0.0441	–0.0668	–	–	–	–	–	–	–	–
Disposable income dummy	0.1125**	0.1212**	0.1174**	0.1252**	0.0228*	0.0263**	0.0397	0.0268	0.1134***	0.1165***	0.1232**	0.1256**
Adjusted R- squared	0.61	0.63	0.64	0.66	–	–	–	–	0.34	0.59	0.45	0.39
AR(1)	–	–	–	–	0.053	0.007	0.101	0.063	–	–	–	–
Sargan test	–	–	–	–	0.102	0.105	0.042	0.057	–	–	–	–
Hansen test	–	–	–	–	0.379	0.274	0.756	0.978	–	–	–	–
No. of observations	103	101	95	93	75	74	66	65	67	67	63	61
No. of countries	33	33	32	32	35	35	34	34	29	29	28	27

Notes: Estimation technique: (I) random effects model with temporal dummies; (II) one step System GMM with small-sample adjustments and orthogonal deviations; (III) IV via two-stage least squares. All variables are expressed in five-year averages and in logs except disposable income dummy variable. * significant at 10% level; ** significant at 5%, *** significant at 1%.

result obtained in the benchmark model using the structural equations in the sense that public investment reduces the levels of economic inequality. Taking into account that this investment is constituted mainly by infrastructures, one would expect that it reduces income inequality indirectly, as explained before.

VI. Conclusions

Recent times have seen government spending, taxation, and deficit financing move to the forefront of policy analysis. Fiscal policy affects aggregate demand, the distribution of wealth, and the economy's capacity to produce goods and services. However, the majority of existing empirical studies have focused on the effects of fiscal policy on economic activity without considering the redistributive effects and, not offering, in turn, an analysis of the impact of different fiscal policy instruments.

In this paper, we consider an unbalanced panel of 43 upper-middle and high income countries for the period 1972–2006 to show that both the magnitude and the composition of the fiscal policy have significant impacts not only on economic growth but also on economic inequality. Therefore, different fiscal policies could be used to affect both growth and income distribution. In this sense, our approach makes it possible to look at the influence of different fiscal instruments simultaneously to economic growth and inequality taking always into account their financial counterpart (in form of direct or indirect taxes).

Regarding the macroeconomic effects of fiscal policies, our empirical results are in agreement with those found in other empirical studies and suggest that cuts of direct taxes increase GDP, whereas increases of public current expenditures diminish it. Beyond that, and unlike other empirical work, our results also show that different fiscal policies have significant redistributive effects: an increase of public expenditure (current or in public investment) produces significant reductions in income inequality, as does increasing direct taxes. Moreover, the estimation of structural equations, where a relation of mutual influence between growth and inequality is allowed for, shows that a reduction in income inequality stimulates economic growth, whereas the process of economic growth reduces economic inequality. Consequently, these results suggest that some previously omitted characteristics of growth are related to inequality, and *vice versa*; therefore we could argue that the orthogonal equations were probably suffering from omitted variables bias. In any case, the results of both types of equations considered are very consistent showing that different fiscal policies have significant growth and distributive effects in the analysed economies. On the other hand, sensitivity analyses indicate that our macroeconomic results are robust to the inclusion of other control variables and also to different estimation techniques considering endogeneity problems.

From a policy perspective, our results have clear implications. According to our estimates, increasing the size of the public sector (through current expenditures and direct taxes) improves the distribution of income at the expense of economic growth. The effects of indirect taxes on both output and inequality are found to be statistically insignificant. Moreover, the novelty of these results is that they indicate that under certain circumstances the classic *trade-off* between efficiency and equity when implementing specific public policies could be avoided. In particular, increasing public investment reduces inequality without harming output, no matter if it is financed through direct or indirect taxes.

Appendix A
Sources and Definitions of Data Used in Regressions

International trade: *World Development Indicators*, World Bank (WDI), exports plus imports as a share of GDP.

Population growth: *World Development Indicators,* World Bank (WDI), annual growth rate of population.

Civil liberties: Freedom House: index on a scale of one to seven, with one representing the higher level and seven representing the lower level of civil liberties.

Education inequality: Castelló and Doménech (2002), Gini index of education.

Inequality: UNU-WIDER version 2b, Gini index.

Private investment: Penn World Tables 6.1 and Government Finance Statistics of International Monetary Fund (GFS-IMF), Total investment (PWT 6.1) minus public investment (GFS-IMF), as a share of GDP.

Human capital: Barro and Lee (2001), average years of schooling of the population aged 25 and over.

Inflation: *World Development Indicators,* World Bank (WDI), December-to-December change in consumer price index (CPI).

GDP: Penn World Table 6.1 database, Real GDP *per capita* (RGDPCH, 2002 PPP$).

GDP growth: Penn World Table 6.1 database, annual GDP growth ($GDP_t - GDP_{t-1}$)

Current public expense: *Government Finance Statistics of International Monetary Fund (GFS-IMF),* current expense of general government as a share of GDP.

Public Investment: *Government Finance Statistics of International Monetary Fund (GFS-IMF)*, public investment of general government as a share of GDP.

Direct taxes: *Government Finance Statistics of International Monetary Fund (GFS-IMF)*, revenues of general government due to direct taxes as a share of GDP.

Indirect taxes: *Government Finance Statistics of International Monetary Fund (GFS-IMF)*, revenues of general government due to indirect taxes as a share of GDP.

Transactions in financial assets and liabilities: Government Finance Statistics of International Monetary Fund (GFS-IMF), revenues minus expenses in financial assets of general government as a share of GDP

Other revenues: Government Finance Statistics of International Monetary Fund (GFS-IMF), revenues of general government due to other taxes, grants and other revenues as a share f GDP.

Government Surplus/Deficit: Government Finance Statistics of International Monetary Fund (GFS-IMF), total revenues minus total outlays of general government as a share of GDP.

Appendix B
Summary Statistics (Within and Between Variations)

		Mean	*Standard deviation*	*Minimum*	*Maximum*	*Observations*
GDP growth	Overall	2.22	2.83	–21.49	13.96	$N = 284$
	Between		1.70	–3.99	5.97	$n = 43$
	Within		2.52	–15.44	10.65	T-bar = 6.60
Log (initial GDP)	Overall	8.75	2.47	0	10.80	$N = 301$
	Between		1.97	2.60	10.22	$N = 43$
	Within		1.52	3.54	15.50	$T = 7$
Inequality (Gini index)	Overall	34.48	9.09	18.66	58.7	$N = 235$
	Between		8.67	22.29	52.77	$n = 43$
	Within		2.64	25.74	43.02	T-bar = 5.46
Current public expense	Overall	17.18	5.64	3.99	39.34	$N = 284$
	Between		5.28	6.88	32.31	$n = 43$
	Within		2.04	10.54	24.76	T-bar = 6.60
Public investment	Overall	4.38	1.72	1.13	9.10	$N = 178$
	Between		1.40	1.90	7.35	$n = 43$
	Within		1.12	1.78	7.97	T-bar = 4.14
Private investment	Overall	15.99	7.18	2.22	45.91	$N = 178$
	Between		6.07	5.35	36.92	$n = 43$
	Within		3.26	1.73	26.07	T-bar = 4.14
Direct taxes	Overall	11.97	6.53	1.67	31.90	$N = 242$
	Between		6.32	2.17	28.35	$n = 43$
	Within		1.97	3.76	20.89	T-bar = 5.63
Indirect taxes	Overall	9.73	3.97	0.01	24.30	$N = 205$
	Between		3.72	2.58	18.82	$n = 42$
	Within		1.90	0.98	16.84	T-bar = 4.88
Other revenues	Overall	4.05	0.83	2.08	5.75	$N = 233$
	Between		0.76	2.60	5.28	$n = 43$
	Within		0.32	3.10	5.24	T-bar = 6
Transactions in financial assets and liabilities	Overall	1.99	4.84	–6.69	44.39	$N = 236$
	Between		2.76	–2.00	11.88	$n = 43$
	Within		3.96	–9.72	34.50	T-bar = 5.49
Government surplus/ deficit	Overall	4.20	6.23	–16.20	28.10	$N = 263$
	Between		4.00	–6.20	14.77	$n = 43$
	Within		4.78	–13.68	18.66	T-bar = 6.11
Population growth	Overall	0.89	0.79	–1.33	3.15	$N = 301$
	Between		0.71	–0.13	2.44	$n = 43$
	Within		0.37	–0.70	1.96	$T = 7$
Human capital	Overall	2.26	1.21	0.39	5.08	$N = 247$
	Between		1.08	0.80	4.66	$n = 36$
	Within		0.57	0.77	3.55	T-bar = 6.86
International trade	Overall	75.54	42.24	13.49	231.53	$N = 269$
	Between		39.97	20.17	190.47	$n = 42$
	Within		15.05	11.23	143.16	T-bar = 6.40
Inflation	Overall	14.71	26.30	–0.34	198.51	$N = 272$
	Between		17.91	2.00	76.66	$n = 43$
	Within		21.00	–49.31	166.44	T-bar = 6.32
Education inequality	Overall	26.57	11.63	9.3	66.00	$N = 252$
	Between		10.82	12.7	54.5	$n = 36$
	Within		4.57	8.85	43.32	$T = 7$
Civil liberties	Overall	2.10	1.68	1	7	$N = 284$
	Between		1.29	1	5.33	$n = 43$
	Within		1.13	–1.47	6.10	T-bar = 6.60

Sources: Fiscal variables comes from GFS – FMI, The Gini coefficient comes from UNU-WIDER version 2b, Investment and GDP comes from Penn World Table 6.1, Education comes from Barro and Lee (2001), Trade and inflation comes from World Development Indicators of the World Bank (WDI-WB), The Gini of education comes from Castelló and Domènech (2002), The variable of civil liberties comes from Freedom House.

Appendix C
Sample of Countries

High income (22):
Australia, Austria, Belgium, Canada, Denmark, Netherlands, Finland, France, Germany, Iceland, Ireland, Israel, Italy, Korea Republic, Luxembourg, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States.

Upper middle income (21):
Argentina, Belarus, Chile, Colombia, Croatia, Czech Republic, Dominican Republic, Greece, Hungary, Jamaica, Latvia, Malaysia, Malta, Mauritius, Peru, Poland, Singapore, Slovak Republic, South Africa, Turkey and Uruguay.

References

Aghion, P. and Bolton, P. 1992, 'Distribution and Growth in Models of Imperfect Capital Markets', *European Economic Review*, vol. 36, no. 2–3, pp. 603–611.
Aghion, P. and Bolton, P. 1997, 'A Theory of Trickle-down Growth and Development', Review *of Economic Studies*, vol. 64, pp. 151–172.
Aghion, P., Caroli, E. and García-Peñalosa, C. 1999, 'Inequality and Growth in the New Growth Theories', *Journal of Economic Literature* vol. 37, pp. 1615–1669.
Alesina, A. and Rodrik, D. 1994, 'Distributive Politics and Economic Growth', *Quarterly Journal of Economics*, vol. 109, pp. 465–490.
Afonso, A., Schuknecht, L. and Tanzi, V. 2010, 'Income Distribution Determinants and Public Spending Efficiency', *Journal of Economic Inequality*, vol. 8, pp. 367–389.
Atkinson, A. and Brandolini, A. 2006, 'The Panel-of-countries Approach to Explaining Income Inequality: An Interdisciplinary Research Agenda', in S. Morgan, D. Grusky and G. Fields (eds), *Mobility and Inequality: Frontiers of Research from Sociology and Economics*, Stanford University Press, Stanford.
Auerbach, A.J. and Kotlikoff, L.J. 1987, *Dynamic Fiscal Policy*, Cambridge University Press.
Baltagi, B.H. 2008, *Econometric Analysis of Panel Data*, fourth edition, Wiley and Sons, Chichester.
Banerjee, A. and Duflo, E. 2003, 'Inequality and Growth: What Can the Data Say?' *Journal of Economic Growth*, vol. 8, no. 3, pp. 267–299.
Banerjee, A. and Newman, A.F. 1993, 'Occupational Choice and the Process of Development', *Journal of Political Economy*, vol. 101, pp. 274–298.
Barro, R.J. 1990, 'Government Spending in a Simple Model of Endogenous Growth', *Journal of Political Economy*, vol. 98, no. 1, pp.103–117.
Barro, R.J. 1991, 'Economic Growth in a Cross Section of Countries', *Quarterly Journal of Economics*, vol. 106, pp. 407–443.
Barro, R.J. 2000, 'Inequality and Growth in a Panel of Countries', *Journal of Economic Growth*, vol. 5, no. 1, pp. 5–32.
Barro, R.J. 2008, 'Inequality and Growth Revisited', *Working Paper Series on Regional Economic Integration,* no. 11, Asian Development Bank.
Barro, R.J. and Lee, J-W. 2001, 'International Data on Educational Attainment: Updates and Implications', *Oxford Economic Papers*, vol. 53, no. 3, pp. 541–563.
Barro, R.J. and Sala-i-Martin, X. 1992, 'Public Finance in Models of Economic Growth', *Review of Economic Studies*, vol. 59, pp. 645–661.
Bénabou, R. 1996, 'Inequality and Growth', NBER Working Paper, no 5658, July.
Bértola, G. 1993, 'Factor Shares and Savings in Endogenous Growth', *American Economic Review*, vol. 83, no. 5, pp. 1184–1198.
Blundell, R. and Bond, S. 1998, 'Initial Conditions and Moment Restrictions in Dynamic Panel Data Models', *Journal of Econometrics*, vol. 87, pp. 115–143.

Blundell, R. and Bond, S. 2000, 'GMM Estimation with Persistent Panel Data: An Application to Production Functions', *Econometric Reviews*, vol. 19, pp. 321–340.
Blundell, R., Bond, S. and Windmeijer, F. 2000, 'Estimation in Dynamic Panel Data Models: Improving on the Performance of the Standard GMM', *Advances in Econometrics*, vol. 15, pp. 53–91.
Bond, S., Hoeffler, A. and Temple, J. 2001, 'GMM Estimation of the Empirical Growth Models', CEPR Discussion Papers, no.3048.
Brenneman, A. and Kerf, M. 2002, 'Infrastructure and Poverty Linkages: A Literature Review', World Bank, Washington, DC.
Bulir, A. and Gulde, A. 1995, 'Inflation and Income Distribution: Further Evidence on Empirical Links', IMF Working Paper, no.86.
Calderón, C. and Servén, L. 2004, 'Trends in Infrastructure in Latin America, 1980–2001', Working Papers Central Bank of Chile, no. 269, Central Bank of Chile.
Caroli, E., 2001, 'New Technologies, Organizational Change and the Skill Bias: What Do We Know', in P. Petit and L. Soete (eds), *Technology and the Future Employment of Europe*, Edward Elgar, London.
Cass, D. 1965, 'Optimum Growth in an Aggregative Model of Capital Accumulation', *Review of Economic Studies*, vol. 32, pp. 233–240.
Castelló, A. and Doménech, R. 2002, 'Human Capital Inequality and Economic Growth: Some New Evidence', *Economic Journal*, vol. 112, no. 478, pp. 187–200.
Castelló-Climent, A. 2010, 'Inequality and Growth in Advanced Economies: An Empirical Investigation', *Journal of Economic Inequality*, vol. 8, pp. 293–321.
Chamely, C. 1986, 'Optimal Taxation of Capital Income in General Equilibrium with Infinite Lives', *Econometrica*, vol. 54, no. 3, pp. 607–622.
Deaton. A.S. and Paxson, C.H. 1997, 'The Effects of Economic and Population Growth on National Saving and Inequality', *Demography of Aging*, vol. 34, no. 1, pp. 97–114.
Deininger, K. and Squire, L. 1996, 'A New Data Set Measuring Income Inequality', *World Bank Economic Review*, vol. 10, no. 3, pp. 565–591.
Diamond, P. 1965, 'National Debt in a Neoclassical Growth Model', *American Economic Review*, vol. 41, pp. 1126–1150.
Dollar, D. and Kraay, A. 2002, 'Growth is Good for the Poor', *Journal of Economic Growth*, vol. 7, pp. 195–225.
Easterly, W. and Rebelo, S. 1993, 'Fiscal Policy and Economic Growth', *Journal of Monetary Economics*, vol. 32, no. 3, pp. 417–458.
Eicher, T. 1996, 'Interaction between Endogenous Human Capital with Technological Change', *Review of Economic Studies*, vol. 63, pp. 127–144.
Enikolopov, R. and Zhuravskaya, E. 2007, 'Decentralization and Political Institutions', *Journal of Public Economics*, vol. 91, no. 11–12, pp. 2261–2290.
Feldstein, M.S. 1974, 'Incidence of a Capital Income Tax in a Growing Economy with Variable Savings Rates', *Review of Economic Studies*, vol. 41, pp. 505–513.
Fields, G.S. 2001, *Distribution and Development: A New Look at the Developing World*, Russell Sage Foundation, MIT Press, New York.
Fölster, S. and Henrekson, M. 1999, 'Growth and the Public Sector: A Critique of the Critics', *European Journal of Political Economy*, vol. 15, pp. 337–358.
Forbes, K. 2000, 'A Reassessment of the Relationship between Inequality and Growth', *American Economic Review*, vol. 90, pp. 869–887.
Galli, R. and van der Hoeven, R. 2001, 'Is Inflation Bad for Income Inequality?' ILO Employment Paper, no. 19.
Galor, O. and Tsiddon, D. 1997, 'Technological Progress, Mobility, and Economic Growth', *American. Economic Review*, vol. 87, no. 3, pp. 363–382.
Galor, O. and Zang, H. 1997, 'Fertility, Income Distribution and Economic Growth: Theory and Cross-country Race Obviousness', *Japan and the World Economy*, vol. 9, no. 2, pp. 197–229.
Galor, O. and Zeira, J. 1993, 'Income Distribution and Macroeconomics', *Review of Economic Studies*, vol. 60, pp. 35–52.

García-Peñalosa, C. and Turnovsky, S.J. 2007, 'Growth, Inequality, and Fiscal Policy with Endogenous Labour Supply: What are the Relevant Tradeoffs?' *Journal of Money, Credit and Banking*, vol. 39, pp. 369–394.

Greenwood, J. and Jovanovic, B. 1990, 'Financial Development, Growth and the Distribution of Income', *Journal of Political Economy*, vol. 98, pp. 1076–1107.

Gupta, D.K. 1990, *The Economics of Political Violence. The Effect of Political Instability on Economic Growth*, Praeger Publishers, New York.

Gustafsson, B. and Johansson, M. 1999, 'In Search of Smoking Guns: What Makes Income Inequality Vary Over Time in Different Countries?' *American Sociological Review*, vol. 64, no. 4, pp. 585–605.

Hassler, J. and Rodríguez-Mora, J.V. 2000, 'Intelligence, Social Mobility, and Growth', *American Economic Review*, vol. 90, no. 4, pp. 888–908.

Helpman, E. 1998, *General Purpose Technologies and Economic Growth*, MIT Press, Cambridge, MA.

Huang H-C. (R.), Lin, Y.-C. and Yeh, C.-C. 2009, 'Joint Determinations of Inequality and Growth', *Economic Letters*, vol. 103, pp. 163–166.

Iimi, A. 2005. 'Decentralization and Economic Growth Revisited: An Empirical Note', *Journal of Urban Economics*, vol. 57, pp. 449–461.

Judd, K.L. 1985, 'Redistributive Taxation in a Simple Perfect Foresight Model', *Journal of Public Economics*, vol. 8, no. 1, pp. 59–83.

Kaldor, N. 1956, 'Alternative Theories of Distribution', *Review of Economic Studies*, vol. 23, pp. 83–100.

Kamps, C. 2005, 'The Dynamic Effects of Public Capital: VAR Evidence for 22 OECD Countries', *International Tax and Public Finance*, vol. 12, pp. 533–558.

King, R. and Rebelo, S. 1990, 'Public Policy and Economic Growth: Developing Neoclassical Implications', *Journal of Political Economy*, vol. 98, no. 5, pp. 126–150.

Kneller, R., Bleaney, M.F. and Gemmell, N. 1999, 'Fiscal Policy and Growth: Evidence from OECD Countries', *Journal of Public Economics*, vol. 74, pp. 171–190.

Koester, R. and Kormendi, R. 1989, 'Taxation, Aggregate Activity and Economic Growth: Cross-country Evidence on Some Supply-side Hypotheses', *Economic Inquiry*, vol. 27, pp. 367–386.

Koopmans, T.C. 1965, 'On the Concept of Optimal Growth', *The Econometric Approach to Development Planning*, Rand McNally.

Krzyzaniak, M. 1967, 'The Long-run Burden of a General Tax on Profits in a Neoclassical World', *Public Finance*, vol. 22, no. 4, pp. 472–491.

Kuznets, S. 1955, 'Economic Growth and Income Inequality', *American Economic Review* vol. XLV, no. 1, pp. 1–28.

Lambert, P.J. 2001, *The Distribution and Redistribution of Income*, third edition, Manchester University Press, Manchester.

Lewis, W. 1954, 'Economic Development with Unlimited Supplies of Labour', *Manchester School*, vol. 22, pp. 139–191

Li, H. and Zou, H. 1998, 'Income Inequality is Not Harmful for Growth: Theory and Evidence', *Review of Development Economics*, vol. 2, no. 3, pp. 318–334.

Li, H., Squire, L. and Zou, H. 1998, 'Explaining International and Intertemporal Variations in Income Inequality', *Economic Journal*, vol. 108, pp. 26–43.

Li, H., Xie, D. and Zou, H. 2000, 'Dynamics of Income Distribution', *Canadian Journal of Economics*, vol. 33, no. 4, pp. 937–961.

Li, H., Xu, L. and Zou, H. 2000, 'Corruption, Income Distribution, and Growth', *Economics and Politics*, vol. 12, pp. 155–182.

Lin S.-C., Kim, D.-H., Huang, H.-C. and Yeh, C.-C. 2009, 'Nonlinearity between Inequality and Growth', *Studies in Nonlinear Dynamics Econometrics*, vol. 13, no. 2, art. 3.

Lucas, R. 1990, 'Supply-side Economics: An Analytical Review', *Oxford Economic Papers*, vol. 42, no. 2, pp. 293–316.

Lundberg, M. and Squire, L. 2003, 'The Simultaneous Evolution of Growth and Inequality', *Economic Journal*, vol. 113, pp. 326–344.

Mankiw, N.G., Romer, R. and Weil, D.N. 1992, 'A Contribution to the Empirics of Economic Growth', *Quarterly Journal of Economics*, vol. 107, no. 2, pp. 407–437.

Mendoza, E., Milesi-Ferretti, G.M. and Asea, P. 1997, 'On the Ineffectiveness of Tax Policy in Altering Long-run Growth: Harberger's Superneutrality Conjecture', *Journal of Public Economics*, vol. 66, pp. 99–126.

Mookherjee, D. and Ray, D. 2003, 'Persistent Inequality', *Review of Economic Studies*, vol. 70, pp. 369–393.

Murphy, K.M., Shleifer, A. and Vishny, R. 1989, 'Income Distribution, Market Size, and Industrialisation', *Quarterly Journal of Economics*, vol. 104, no. 3, pp. 537–564.

Murray, M.P. 2006, 'Avoiding Invalid Instruments and Coping with Weak Instruments', *Journal of Economic Perspectives*, vol. 20, no. 4, pp. 111–132.

Partridge, M.D. 1997, 'Is Inequality Harmful for Growth? Comment', *American Economic Review*, vol. 87, no. 5, pp. 1019–1032.

Perotti, R. 1994, 'Income Distribution and Investment', *European Economic Review*, vol. 38, no. 3–4, pp. 827–835.

Perotti, R. 1996, 'Growth, Income Distribution and Democracy: What the Data Say', *Journal of Economic Growth*, vol. 1, no. 2, pp. 149–187.

Perotti, R. 2005, 'Estimating the Effects of Fiscal policy in OECD Countries', CEPR Discussion Paper, no. 4842.

Persson, T. and Tabellini, G. 1994, 'Is Inequality Harmful for Growth?' *American Economic Review*, vol. 84, pp. 600–621.

Piketty, T. 1997, 'The Dynamics of the Wealth Distribution and the Interest Rate with Credit Rationing', *Review of Economic Studies*, vol. 64, no. 2, 173–189.

Ramos, X. and Roca-Sagalés, O. 2008, 'Long-term Effects of Fiscal Policy on the Size and Distribution of the Pie in the UK', *Fiscal Studies*, vol. 29, no. 3, pp. 387–411.

Rebelo, S. 1991, 'Analysis and Long-run Growth', *Journal of Political Economy*, vol. 99, no. 3, pp. 500–521.

Robinson, S. 1976, 'A Note on the U Hypothesis Relating Income Inequality and Economic Development', *American Economic Review*, vol. 66, no. 3, pp. 437–440.

Romp W. and Haan, J. 2007, 'Public Capital and Economic Growth: A Critical Survey', *Perspektiven der Wirtschaftspolitik*, vol. 8, pp. 6–52.

Saint-Paul, G. and Verdier, T. 1993, 'Education, Democracy and Growth', *Journal of Development Economies*, vol. 42, pp. 399–407.

Sato, K. 1967, 'Taxation and Neo-Classical Growth', *Public Finance*, vol. 22, no. 3, pp. 346–370.

Summers, L.H. 1981, 'Capital Taxation and Accumulation in a Life Cycle Growth Model', *American Economic Review*, vol. 71, no. 4, pp. 533–544.

Voitchovsky, S. 2005, 'Does the Profile of Income Inequality Matter for Economic Growth? Distinguishing Between the Effects of Inequality in Different Parts of the Income Distribution', *Journal of Economic Growth*, vol. 10, pp. 273–296.

Wood, A., and Ridao-Cano, C. 1999, 'Skill, Trade and Internationally Inequality', *Oxford Economic Papers*, vol. 51, pp. 89–119.