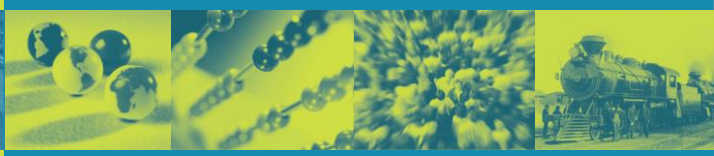
KU LEUVEN
DEPARTMENT OF ECONOMICS

DISCUSSION PAPER SERIES
DPS17.07

June 2017



Sub-national fiscal autonomy, infrastructure investment and regional disparities

Paul VAN ROMPUY

Public Economics

Faculty of Economics
and Business

Sub-national Fiscal Autonomy, Infrastructure Investment and Regional Disparities

PAUL VAN ROMPUY

Department of Economics, KU Leuven, Naamsestraat 69, 3000 Leuven, Belgium

Email: paul.vanrompuy@.kuleuven.be

Abstract. This paper focusses on the relationship between subnational fiscal autonomy, transport infrastructure investment and regional disparities in 30 OECD countries over the period 1995-2011. Subnational fiscal autonomy is approximated by the revenue share of autonomous taxes. A fixed effects panel estimation reveals that SNG tax autonomy significantly contributes to regional convergence although its impact is small when compared to the effect of transport infrastructure investment. Subnational expenditure on education and economic affairs does not impact spatial disparities.

Keywords: *Subnational tax autonomy, fiscal decentralization, regional disparities, infrastructure investment.*

JEL Classification: H 71, H 77, R 12

1. INTRODUCTION.

According to the 2016 report on fiscal federalism (Blöchliger and Kim, 2016), the OECD area has become more decentralized over the last two decades, as judged from the expenditure and revenue shares of the sub-national governments (SNGs). But when compared to the period of 1970-1995, the intensity and scope of the process of devolution, on average, appears to have lost its impetus in the recent past. However, this general tendency masks divergent institutional changes whereby the SNG revenue and expenditure share increased in federal countries such as Spain, Canada, Germany and Belgium and declined in some unitary countries (e.g. Norway and the Netherlands) since 1995.

Simultaneously, ongoing economic, financial and cultural globalisation has challenged policy makers to boost the competitiveness of their national economies. And since achieving a more efficient allocation of resources was a major economic argument for devolution, fiscal decentralisation has become instrumental in coping with this new international environment (Rodriguez-Pose and Ezcurra, 2010). Along this line of thought the Central European transition economies were already urged in the 1990s to take substantial steps towards decentralization in view of the 2004 and 2007 EU Enlargement (Rodriguez-Pose and Kroijer, 2009).

Decentralized governments will- according to the early proponents of fiscal federalism (Tiebout, 1956; Oates, 1972)- deliver an efficient allocation of resources that is tailored to the heterogeneous preferences of their citizens, mobilise unused productive capacities and promote inter-jurisdictional competition. The second generation fiscal federalism theory (Qian and

Weingast,1997; Weingast, 2009) complemented this optimistic view of decentralisation by specifying the institutional characteristics of the "market preserving federalism" which are necessary for the implementation of the predicted efficient outcomes.

Although in theory efficiency and equity can go hand in hand when decentralisation results in the productive use of idle resources, serious doubts have been raised regarding the distributive aspects of fiscal federalism. Musgrave (1959) pointed out that the redistributive function should appropriately be assigned to the central government. Pre-existing regional imbalances could indeed be aggravated by the process of devolution (Martinez-Vazquez and McNab, 2003) and risk being inadequately dealt with by a central government that is devoid of its distributive capacities as a result of fiscal decentralisation. Empirical studies on the link between fiscal decentralisation and regional disparities lead to divergent results depending on the level of development in the countries examined. In developing countries, that lack well-established, adequate institutions, fiscal decentralisation does not promote regional equalisation, whereas in high-income countries devolution apparently tends to narrow regional disparities of GDP per capita (Lesmann, 2012; Rodriguez-Pose and Ezcurra, 2010).

In the empirical studies referred to, fiscal decentralization is commonly measured by the sub-national share of government expenditure or revenue. The approach followed in this paper differs from previous research in the measurement of fiscal autonomy, drawing from the OECD classification of sub-national tax revenue according to the discretionary tax power SNGs can exert. Additionally, attention is given to the potential equalising impact of transport infrastructure investment, irrespective of whether it is financed by the central government or by the SNGs.

The main research questions are:

- To what extent does sub-national tax autonomy contribute to a reduction of regional disparities in the framework of fiscal decentralization?
- Does transport infrastructure investment play a complementary role with respect to tax autonomy or does it rather act as its substitute for narrowing regional disparities?
- Do other sub-national expenditure categories such as education and economic affairs have an equalising role?

The remainder of the paper is organised as follows. The literature and empirical research on the subject will be briefly summarised in the next section. The data and the specification and estimation method of the basic model will then be given. The empirical results will follow. The final section summarises the main conclusions.

2. THEORETICAL BACKGROUND AND RELATED EMPIRICAL RESEARCH

2.1 Fiscal Decentralization and Regional Disparities: Theoretical Arguments.

The academic interest in the long-term convergence of countries and regions began in the beginning of the 1990s with several seminal papers that originated in the neoclassical growth theory (Barro, 1991; Barro and Sala-i-Martin, 1992). In this approach, the existence of long-term regional convergence within a country could be tested econometrically in a rigorous way,

implying that the dispersion of regional GDP per capita would decrease over time. Interregional mobility of capital and labour would, in this view, accelerate the speed of convergence. The underlying neoclassical growth model assumed, however, that all regions within a country where convergence applies, would converge to the same steady state, irrespective of their different structural characteristics. This assumption is apparently far from reality. The introduction of conditional instead of absolute convergence, was therefore a logical extension of the original convergence model, allowing the regions to tend to their respective steady state. The latter would be determined by specific regional features such as the existing industrial specialisation, the regional labour market and infrastructure characteristics (Martin and Sunley, 1998).

The conditional nature of the regional growth process relates in particular to the institutional framework of the regional economy, including the degree of political decentralization. Democratically elected regional governments that are to some extent autonomous in determining their tax revenue and the level and structure of expenditure will have strong incentives to tailor their programmes to the preferences of their electorate in view of their re-election. This is according to the predictions of the "second generation fiscal federalism" (Weingast, 1995,2014; Qian and Weingast, 1997; Ezcurra and Pascual, 2008). Fiscal decentralisation, installing tax and expenditure autonomy, will induce regional governments to compete for private investment by granting tax cuts (Hines, 1996). They may also be inclined to make regional labour markets more flexible and to invest in productive infrastructure (Kappeler *et al*., 2013). In this way, less developed regions can successfully compete with their richer counterparts, thus reducing interregional income differences.

However, Rodriguez-Pose and Ezcurra (2010) point to the conditioning role of the economic environment in which decentralisation operates. The virtuous effects of fiscal decentralisation and inter-jurisdictional competition on regional disparities may be valid in developed countries with well-established institutions and relatively modest existing regional economic inequality. Tanzi (1996) questions the equalising effect of decentralisation in developing countries because of coordination issues between the central and local governments and of the risk of corruption of the local administration that lacks experience and professionalism. Kyriacou *et al*. (2015) investigate the role of government quality as an important factor that differentiates the potential impact of fiscal decentralization on regional inequality.

2.2 Related Empirical Research

Regional inequality has been treated from two related points of view: regional household income inequality as a component of overall income inequality or regional differences in labour productivity, measured by regional gross domestic product (GDP) per capita.. These two indicators of inequality are of course closely interrelated but at the same time, they are fundamentally different. Regional differences of GDP per capita are the primary source of regional income inequality, whereas the latter also reflects the impact of income taxes and of social security contributions and benefits. Interregional commuting will, in addition, result in a wedge between regional value added and household income. Therefore, cross-country studies on regional income disparities ought to take into account differences in income taxation and social security and welfare systems (see e.g. Geppert and Stephan, 2008). In the following

sections, the focus will be on the relationship between fiscal decentralization and regional inequality of GDP per capita.

The most common measures of regional variation of GDP per capita, which are used in empirical studies, range from the coefficient of variation, the population-weighted coefficient of variation and the Gini coefficient. The choice of the spatial units covered in these studies depends to a large extent on the availability of detailed regional accounts: for OECD countries large regions (TL2) are commonly referred to. In some studies, NUTS2 regions have been chosen as the unit of analysis. This choice has been criticised, i.e. by Cheshire and Magrini (2000) because of the arbitrarily defined boundaries, although this criticism also applies to the TL- classification. The proxy for fiscal decentralization varies from study to study, although the share of subnational expenditure in overall government expenditure has been frequently used, complemented in some cases by indicators of political decentralization.

Empirical research on the topic dealt with here can be classified into specific country studies on the one hand, and cross-country studies using panel data or studies of a timeless, pure cross-section format on the other. Rodriguez-Pose and Ezcurra (2009, p. 16) mention eleven single country studies, covering developing countries as well as the UK and the US. In all, decentralisation is shown to increase regional disparities. Regional convergence has been shown to be positively correlated with decentralisation in the case of Italy (Calamai, 2009) and China (Wei and Wu (2001). Rodriguez-Pose and Ezcurra (2010) conclude from a study of 26 high and low income countries over the period of 1990-2005 that the impact of the subnational share of expenditure on regional inequality proved to be statistically insignificant. In subsamples of developed and developing countries, decentralisation had a significant negative effect on regional disparities in high income countries in contrast to developing countries. Lessmann (2012) in an extensive study, covered 56 countries at different stages of economic development over the period of 1980-2009. He found that different fiscal decentralisation measures, referring to expenditure, revenue or tax decentralisation significantly affected regional inequality. However, their effect was conditioned by the level of development: above a threshold level of income, decentralisation contributed to a reduction of disparities in contrast to its impact in low income countries where a positive effect on regional inequality was found. These findings are in line with the results obtained by Rodriguez-Pose and Ezcurra (2010) and confirm the important role of institutional quality in the reduction of regional imbalances, as referred to in the preceding section. Finally, Sorens (2014) found in an empirical analysis of 25 OECD countries over the period of 1980-2005 that lower-income regions tend to catch up with higher-income regions only if the former enjoy substantial economic powers.

3. DATA AND ESTIMATION DESIGN

3.1 Data and Variables Used

The disparity measures applied in this paper are derived from gross domestic product per capita data covering the period of 1995-2011 and are obtained for the majority of the 30 countries from the OECD regional statistics database. The exceptions are data for Austria and Belgium (1995-1998) and Chile (1995) which were put at our disposal by courtesy of Ch. Lessmann. The preferred territorial classification is TL2, except for the geographically "small" countries

where TL3 is used: Belgium, Estonia, Ireland, the Netherlands, New Zeeland, the Slovak Republic and Slovenia.

Two measures of regional disparity are put forward: the coefficient of variation denoted by *Rd* and the population weighted coefficient of variation *Wrd*. In contrast to the (unweighted) coefficient of variation that is closely linked to the neoclassical approach of convergence (Martin and Sunley,1998, p. 221), the population weighted coefficient of variation takes into account the different population sizes of the regions and allows for a realistic comparison of regions (Ezcurra and Pascual, 2008). The two disparity measures *Rd* and *Wrd* have the advantage of their independence of the number of regions in the analysis. Moreover, they satisfy the Pigou-Dalton transfer principle (Cowell and Jenkins, 1995), according to which a transfer from a poor region to a richer one reduces inequality. Other measures of concentration such as the Gini coefficient adjusted for the number of regions, the Herfindahl index and the Theil index also satisfy the Pigou-Dalton principle and have been applied in the related literature. But as shown in Lessmann (2006, 2012), both the Herfindahl and Theil indexes are sensitive to the number of regions and are therefore not adequate in cross-country studies of regional inequality. Both the population weighted and unweighted coefficient of variation and the adjusted Gini coefficient are in Lessmann's study of regional inequality of 56 countries over the period of 1980-2009 and are highly and positively correlated. In order to illustrate the landscape of regional disparities in the 30 countries considered here, the values of both dispersion measures *Rd* and *Wrd*, averaged over the period of 1995-2011, figure in Table 1.

Table 1. Average disparity measures (1995-2011) and spatial units

Country	Rd	Wrd	Unit	Country	Rd	Wrd	Unit
Australia	0.17	0.09	8TL2	Japan	0.12	0.12	10TL2
Austria*	0.20	0.21	9TL2	Korea	0.37	0.28	16TL2
Belgium*	0.35	0.36	11TL3	Mexico	0.46	0.62	32TL2
Canada	0.29	0.18	13TL2	Netherlands	0.18	0.15	12TL3
Chile*	0.47	0.35	15TL2	New Zealand	0.23	0.21	14TL3
Czech Rep.	0.40	0.36	8TL2	Norway	0.21	0.25	7TL2
Denmark	0.17	0.19	5TL2	Poland	0.22	0.31	16TL2
Estonia	0.40	0.49	5TL3	Portugal	0.21	0.25	7TL2
Finland	0.21	0.21	5TL2	Slovak Rep.	0.50	0.47	8TL3
France	0.18	0.34	22TL2	Slovenia	0.22	0.21	12TL3
Germany	0.30	0.21	16TL2	Spain	0.19	0.21	19TL2
Greece	0.18	0.24	13TL2	Sweden	0.17	0.21	8TL2
Hungary	0.36	0.43	7TL2	Switzerland	0.16	0.17	7TL2
Ireland	0.31	0.43	8TL3	United Kingdom	0.26	0.30	12TL2
Italy	0.25	0.27	21TL2	United States	0.37	0.17	51TL2

Source: Own calculations from O.E.C.D. Regional Statistics except values denoted by*, obtained by courtesy of Ch. Lessmann (Austria, Belgium: 1995-1998; Chile: 1995).

Their correlation coefficient amounts to 0.75. In vast countries such as Australia, Canada and the US, the population weighted coefficient of variation is significantly smaller than its unweighted counterpart, since less populated regions receive smaller weights. It is also worth noticing that the average regional disparities in the six European transition countries (Estonia, the Czech and Slovak Republics, Hungary, Poland and Slovenia) largely exceed (average *Rd*= 0.35) those in the fourteen remaining EU countries (average *Rd*=0.23). Regional inequality does not show a general trend during the period of 1995-2011, although in the majority of the countries reviewed, *Wrd* tended to increase. If an increase of 5 percentage points of *Wrd* during this period marks the dividing line, spatial inequality became more pronounced in Canada, the Czech Republic, France, Greece, Hungary, Ireland, Korea, Mexico, the Slovak Republic and the UK.

In the empirical analysis presented here, the two measures of dispersion have been averaged over four periods (1995-2002, 2002-2005, 2005-2008 and 2008-2011) for reasons that are related to the availability of data on the preferred fiscal decentralisation variable. Unlike other researchers on the topic, fiscal decentralisation will not be approached by the subnational expenditure since some of the SNG expenditure may be mandated by the central government and financed by transfers or shared taxes. In this way, the fiscal autonomy of the SNGs will be overestimated, a bias that has been recognised in related research on fiscal decentralisation (Stegarescu, 2005; Ezcurra and Pascual, 2008). A more precise and preferred indicator of subnational fiscal autonomy can be found in the tax autonomy tables of the OECD Fiscal Decentralization Database that are available for 1995, 2002, 2005, 2008 and 2011. These tables distinguish tax revenue for regions and local governments of 34 OECD countries according to the discretionary power SNGs have on tax rates and reliefs, on rates or on reliefs only. In this paper, autonomous tax revenue refers to taxes for which the SNGs have discretionary power over one or more of these tax characteristics. It is denoted by the variable *Tax* and has been calculated as the ratio of autonomous tax income to total consolidated or "own" SNG revenue, including shared taxes, grants, user fees and property income. In the nine federal countries studied (Australia, Austria, Belgium, Canada, Germany, Mexico, Spain, Switzerland, US) the tax variable is a weighted average of the regional and local tax autonomy indicators. The weights are the respective revenue shares. In unitary countries, *Tax* refers to the tax autonomy of local governments. In the federal countries, the spatial correspondence between the territorial classification (TL2) and the constitutionally defined regional jurisdictions is acceptable, except in the case of Belgium where, for reasons of statistical representation, 11 TL3 spatial units are distinguished, each of them geographically smaller than the 3 constitutional Regions. In unitary countries, the distinguished spatial units are aggregates of the jurisdictions of the local governments. In order to synchronize the measures of dispersion *Rd* and *Wrd* (averaged over each of the four sub-periods mentioned above with the *Tax* variable), the latter represent averages for each of the four sub periods. This procedure assumes that the period averages of *Tax* and the dispersion variables *Rd* and *Wrd* are representative for the years preceding and following the mid-point of each of the four periods covered. A final remark concerns the number of countries, i.e. 30, retained in the empirical analysis. Four of the 34 OECD countries that figure in the tax autonomy tables were excluded either in view of the small number of regions (Iceland and Luxemburg) or because of the lack of sufficient data on regional GDP per capita (Israel and Turkey).

In addition to the measures of regional dispersion and the tax autonomy variable, macroeconomic variables such as real national *GDP* per capita and the business cycle

indicator *Gap* are obtained from OECD data and averaged over the four periods mentioned. Preference is given here to the output gap as a straightforward business cycle indicator over nationwide unemployment rates that react with time lags to changes in output. In addition to regional and local fiscal autonomy, the structure of SNG expenditure may turn out to be relevant in the explanation of regional disparities. In this respect, expenditure on education and infrastructure projects may be instrumental in boosting the competitive position of the SNGs, resulting in a reduction of regional disparities. The IMF Government Finance Statistics contain a functional classification of subnational expenditure (the COFOG files) over the period of 2000-2009 for most of the countries in the analysis, except for Canada, Chile and Mexico. For Germany, Korea and Japan data are only available for some years of the period considered here.

In addition to the microeconomic data discussed above, other nationwide variables may also contribute to the explanation of regional disparities. In the first place, transport infrastructure investment significantly affects regional development (OECD, 2002). The relevant variable used in this framework is total expenditure on inland transport investment and maintenance, expressed as a percentage of GPD and denoted by *Inv*. The OECD database contains information on *Inv* for the period 1995-2011 for all 30 countries under review. Although no information is provided on the financing of these outlays (SNGs, central government, public or private) nor on the regional allocation of *Inv*, it may be assumed that infrastructure investment generates positive externalities for some or all regions and therefore contributes in this way to a reduction of regional inequality (Kelejian and Robinson, 1997). Second, all countries considered here have been exposed during the estimation period to increasing economic globalisation that, according to Giannetti (2002) and Rodriguez-Pose and Gill (2006), adversely affects regional inequality both on theoretical and empirical grounds. In order to test for the impact of international trade on regional disparities, the macroeconomic openness to trade has been approached through the variable *Open*, i.e. the ratio of the sum of exports and imports to GDP, which has been obtained from national statistics from The World Bank.

Time-invariant data on cultural, ethnic or religious heterogeneity and on the spatial agglomeration of economic activities will also figure in the empirical analysis. Alesina *et al.* (2002) showed that ethnic fragmentation has a particularly negative impact on economic growth and is moreover negatively correlated with GDP per capita. The variable *Frag* denotes the ethnic fragmentation index for each of the 30 countries studied and is obtained from Alesina's 2002 paper. As for potential agglomeration effects on regional disparities, preference is given to the index (b) suggested by Uchida and Nelson (2008). This index takes into account, not only population density, but also the mobility of the urban population through transportation networks. It is denoted by *Aggl*.

The quality of subnational governments has been shown, among others, by Kyriacou *et al.* (2015) mentioned above, to be influential in the explanation of regional inequality. These authors rely on the Country Risk Guide in order to assess political, economic and financial risk among countries. Since this data source is not publicly accessible, country information on government quality was obtained from the World Bank Governance Data (Kaufmann *et al*., 2009), despite the critique on these data, e.g. by Thomas (2010). More specifically, the government effectiveness index, averaged over the period of 1996-2011, is considered to be relevant in the empirical analysis; it will be denoted by *Gefav*. This index does not explicitly refer to sub-national governments; it reflects the perception of the effectiveness of government policies in general for the country as a whole.

Finally other structural features of the economies considered here are potential candidates in the explanation of regional inequality: the size of their central government, their federal or unitary status and the importance of transfers in SNG revenue. The size of the central government (*Cgov*), measured by its share in total government expenditure, matters on prior grounds since it reflects its redistributive capacity aiming at mitigating regional inequalities (Rodriguez-Pose and Ezcurra, 2010). The share of transfers received from other governments in total regional revenue (*Transf*), mirrors the transfer dependency of the regions that, contrary to fiscal autonomy, is not expected to contribute to strengthening the economic tissue of the local economy (Kessler and Lessmann, 2010). The dummy variable *Fed* represents the federal structure of the country and can be conceived as a catch-all of all potentially favourable effects on regional inequality of political and economic decentralisation. The sample of 30 countries contains 9 federations: Australia, Austria, Belgium, Canada, Germany, Mexico, Spain, Switzerland and the United States. The 21 unitary countries studied are: Chile, the Czech Republic, Denmark, Estonia, Finland, France, Greece, Hungary, Ireland, Italy, Japan, Korea, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Sweden and the United Kingdom.

3.2 Model Specification

The institutional and cultural diversity of the 30 OECD countries studied in this paper suggests a fixed effect framework for the panel data analysis of regional disparities. The particular nature of the data i.e. 4 sub-periods of the 1995-2011 time span results in 120 observations of each time-varying variable included in the basic specification. The small number of points in time, in comparison with the spatial dimension, implies that the parameter estimates will predominantly reflect cross-section effects of the explanatory variables and to a lesser degree their dynamic impact.

The basic empirical specification has the following form:

$$Disparity_{it} = \alpha + \beta_1.Tax_{it} + \beta_2.Inv_{it} + \beta_3.Tax\ x\ Inv_{it} + \beta_4.LogGDP_{it} + \beta_5.Open_{it} + \beta_6.Gap_{it} + \gamma_1.Frag_i + \gamma_2.Aggl_i + \gamma_3.Gefav_i + \gamma_4.Cgov_i + \gamma_5.Transf_i + \gamma_6.Fed_i + \tau_i + \mu_{it}$$

$$(i=1,2,3,\ldots 30\ ;\ t = 1,2,3,4) \qquad (1)$$

where $Disparity_{it} = Rd_{it}$, Wrd_{it} ; *i* and *t* denote the *i*-th country and time, respectively. The fixed cross-section effect is represented by τ and μ is the time- and country-specific error term.

The impact of tax autonomy on regional disparities, in the absence of infrastructure investment, is reflected by β_1 which is assumed to be strictly negative. The same holds for the independent effect of infrastructure investment: $\beta_2<0$. The appearance of the interaction variable *Tax x Inv* requires further explanation. Since fiscal autonomy fosters the accountability of the regional government towards its electorate, it is clear that SNGs will pursue expenditure and tax policies with benefits that are maximally internalised in their own jurisdiction. On the other hand, infrastructure investment, albeit it financed by regions or by the central government, typically generates positive externalities for all or some regions and has the characteristics of a public good (Kelejian and Robinson, 1997). If e.g. infrastructure development improves the accessibility of poorer regions and interregional mobility of goods and labour, it certainly contributes to the reduction of regional inequality (for the case of Latin America, see e.g. Calderon and Servén, 2010). The positive effect of tax autonomy, if any, on regional disparities, can therefore be complemented by infrastructure investment. Alternatively, infrastructure

investment can be a substitute for a low degree of tax autonomy and it supports regions in their development that are to a large extent dependent on shared taxes and transfers. To the extent that β_1 , $\beta_2<0$, β_3 will be strictly positive. The parameter β_3 represents the impact of tax autonomy on regional inequality. It is conditional on the effect of infrastructure investment or alternatively, the infrastructure investment effect on disparities conditional on the fiscal autonomy of the regions.

The regional inequality impact of the level of development, is represented by β_4 , the parameter of *LogGDP*. Vast literature exists on the link between development and spatial inequality, surveyed e.g. by Lessmann (2011). He finds evidence of an inverted-U relationship between regional inequality and the level of GDP per capita and of an increase of spatial inequality in late stages of economic development. Since the majority of the 30 OECD countries studied here can be classified as high income economies, a positive sign of β_4 can reasonably be expected.

In the line with the findings of Gannetti (2002) and Rodriguez-Pose and Gill (2006), the impact of international trade on regional disparities is assumed positive, i.e. resulting in regional divergence, implying $\beta_5>0$. The empirical research on the impact of the aggregate business cycle on regional convergence is rather scarce and focusses primarily on income disparities. Magrini *et al*. (2013) concluded in their study of 48 States of the US over the period of 1989-2007 that the aggregate business cycle exerted pro-cyclical effects on regional income divergence. They argued that this effect resulted from the divergent pattern of regional specialization whereby regions specialised in innovative activities benefit most from an economic upswing in contrast to regions characterised by traditional industries. The corollary of this argument is that if regions are not significantly different with respect to their economic specialisation and competitiveness, the aggregate business cycle will not distort the existing disparities in GDP per capita. Therefore, no prior assumption can be made about the sign of β_6..

The arguments developed in the preceding section suggest that fragmentation adversely affects regional disparities ($\gamma_1 >0$), contrary to the effect of the size of the central government ($\gamma_4 <0$) and of the effectiveness of government policies in general ($\gamma_3 <0$. The theoretical arguments for including measures of spatial agglomeration in the explanation of regional disparities are reviewed e.g. by Gardiner *et al.*(2010). They draw on the "new economic geography" models that, on the one hand, predict that under certain assumptions about competition on the markets for goods and the production technology and factor mobility, spatial agglomeration of economic activities will result, implying larger disparities. On the other hand, spatial transaction costs will encourage the dispersion of firms and workers, favouring convergence. This family of models balances concentration and dispersion forces, whereby agglomeration tendencies tend to dominate and consequently, regional disparities will ultimately increase. However, the tendency for increased spatial concentration may engender congestion effects and negative externalities resulting in a dispersion of economic activities and a reduction of regional inequality. The unclear predictions of the "new economic geography" with respect to regional disparities are confirmed in the empirical findings of Gardiner *et al*. for 15 EU member countries over the period of 1981-2007. The mixed empirical results of the link between agglomeration and regional inequality suggest that the sign of γ_2 cannot be defined on prior grounds. As for the impact on regional disparities of *Trans*, the share of transfers in SNG revenue, the opposite sign of the tax variable will be reasonably expected: $\gamma_5>0$ (Kessler and Lessmann, 2010). Finally, as for the sign of the federal dummy variable, *Fed*, the related

empirical studies reviewed in the preceding section suggest that decentralisation may affect regional inequality in a positive or negative way, leaving the sign of γ_6 undetermined.

The third research question stated in the introduction of this paper referred to the potential impact of sub-national expenditure categories, such as education and economic affairs on regional inequality, at given levels of tax autonomy. Rodriguez-Pose and Ezcurra (2010) included- in addition to education and economic affairs- expenditure on health and social protection, arguing that these public provisions could make a difference with respect to regional disparities in their sample of developing and developed countries. The functional classification of sub-national government expenditure in the IMF Government Finance Statistics does not include data for Canada, Chile and Mexico. Data on subnational expenditure on education (*Educ*) and economic affairs (*Econ*) over the period of 2000-2009 could be obtained from this source for the other 27 countries, although only for some years for Germany, Korea and Japan. For the other countries the time-invariant variables *Educ* and *Econ* represent period averages of their respective expenditure shares.

The alternative specification of equation (1), including the regional expenditure shares on education and economic affairs is:

$$Disparity_{it} = \alpha + \beta_1.Tax_{it} + \beta_2.\ Inv_{it} + \beta_3.Tax\ x\ Inv_{it} + \beta_4.\ LogGDP_{it} + \beta_5.\ Open_{it} + \beta_6.\ Gap_{it} + \gamma_1.\ Frag_i + \gamma_2.\ Aggl_i + \gamma_3.\ Gefav_i + \gamma_4.\ Cgov_i + \gamma_5.\ Transf_i + \gamma_6.\ Fed_i + \gamma_7.\ Educ_i + \gamma_8.Econ_i + \tau_i + \mu_{it}$$

(i=1,2,…27; t=1,2,3,4) (2)

If poorer regions succeed in reducing the gap with the richer ones in spending relatively more on education and economic affairs, the expected sign of these variables in (2) is strictly negative. However, a potential endogeneity problem arises with respect to these variables since education and economic affairs typically are income-elastic social goods resulting in higher expenditure shares as income increases. As a consequence, no prior assumptions can be made regarding the sign of γ_7 and γ_8.

3.3 Estimation Method

The wide variety of the institutional and cultural characteristics of the countries under review presumably add, in addition to the variables included in the specification of equations (1) and (2), to the explanation of the observed regional disparities and suggest therefore a fixed-effects panel data estimation method. The cross-section fixed-effects refer to the time-invariant variables above and to the stochastic error term τ_i. A fixed-effects estimation of the model, assuming it is relevant, does not allow, however, for the identification of the parameters of the time-invariant variables. In order to overcome this problem Hausman and Taylor (1981) suggested a two-step estimation procedure, whereby in the first step the fixed-effects model is estimated without the time-invariant variables. In the second step, the fixed-effects vector estimated in the preceding step is decomposed into estimates of the parameters of the time-invariant variables and error terms using instrumental variables (IV). A pragmatic solution to the choice of the appropriate instruments has been suggested by Chatelain and Ralf (2010). These authors use simple *t*-statistic tests instead of the prior assumptions about the correlations between the candidate IV-variables and the time-invariant variables as in Hausman and Taylor (1981) and commented upon by Greene (2012, 435-436). This solution is applied in this paper

to the generalized least squares heteroscedastic robust estimation of equations (1) and (2). Previously, the Hausman specification test (Hausman, 1978) was applied and implied a rejection of a random-effects model in favour of a fixed-effects approach.

The estimation results of the equations (1) and (2) could, in principle, suffer from an endogeneity bias resulting from the treatment of the tax autonomy variable (*Tax*) and the time-invariant transfer share (*Transf*) as exogenous to regional disparity. It is indeed conceivable that substantial regional inequalities trigger a process of devolution, initiated by the political pressure of the poorer or richer regions or both on the central government. Devolution in Belgium, which started as early in 1970 with the decentralisation of cultural affairs, may be illustrative in this respect. Modest steps in the direction of fiscal decentralisation were made in 1980 and in 2001, although the regions used their fiscal autonomy to some extent only in the second decade of this century. This example shows that the constitutional transfer of fiscal competences from the central government to the regions and the effective use of their tax autonomy by the latter, may take considerable time. Since the panel data used here cover only 16 years, divided into 4 time periods, the potential dynamic interaction of regional inequality and fiscal decentralisation may be under-exposed in favour of the timeless cross-section effects of tax autonomy on regional disparities. This argument also holds for transfers, that are roughly considered here as complements to autonomous taxes from the central government to the regions (1). The potential endogeneity bias in the model could be remedied in a pragmatic way by substituting lagged values for the tax autonomy and transfer variables. However, through this approach the degrees of freedom, that are already limited in view of the small number of time periods in the data set, would subsequently be further reduced.

4. EMPIRICAL RESULTS

4.1 Results for 30 OECD Countries

The estimation results of equation (1) are reported in Table 2. The first panel of the table contains the parameter estimates of equation (1) without the interaction variable *Tax x Inv* that figures in the second panel. Taken separately, the parameter estimates of the tax and investment variable, are statistically insignificant, indicating that regional disparities are insensitive to fiscal decentralisation and infrastructure investment both operating as independent policy instruments in dealing with spatial inequality. The insignificant role of fiscal decentralisation in coping with regional disparities can be explained by the fact that poorer regions face a substantially smaller tax base in comparison with richer SNGs. Tax cuts initiated by the former in order to attract firms and to stimulate net inflows of tax paying households would severely deteriorate the SNG fiscal stance in the medium term, thus rendering this policy strategy unattractive. Rodriguez-Pose and Ezcurra (2010) found that fiscal decentralisation favoured regional convergence only in OECD and EU high income countries and resulted in spatial inequality in developing countries. The negative but insignificant impact of *Tax* on *Rd* and *Wrd* could be ascribed to the characteristics of the sample of 30 OECD countries, among which are relatively low income countries such as Mexico, Chile and the European transit economies, along with richer economies.

Table 2. Impact of tax autonomy and infrastructure investment on regional disparities

	No interaction		Interaction model	
Dep. Variable	**Rd**	**Wrd**	**Rd**	**Wrd**
Tax	-0.0007	-0.0007	-0.0030***	-0.0025**
	(1.4171)	(1.0735)	(3.8567)	(2.088)
Inv	0.0050	-0.0195	-0.0389***	-0.0522**
	(0.5623)	(1.1815)	(2.6807)	(2.0164)
Tax x Inv			0.0024***	0.0018
			(3.8567)	(1.6300)
Log GDP	0.2266**	0.2648**	0.1820***	0.2316**
	(2.4308)	(2.2750)	(2.8479)	(2.1749)
Open	0.0001	0.0003	0.0003	0.0004
	(0.1328)	(0.3523)	(0.6069)	(0.0545)
Gap	-0.0026*	-0.0009	-0.0022**	-0.0006
	(1.9077)	(0.4269)	(2.2147)	(0.3208)
Constant	-0.0419	-0.0809	0.0497	-0.0127
	(0.4577)	(0.7294)	(0.7844)	(0.1280)
R^2	0.9700	0.9489	0.9756	0.9512
Adjusted R^2	0.9579	0.9285	0.9655	0.9309
Instrumental variables estimation				
Frag	0.1876	0.2485*	0.1876*	0.2359*
	(1.4635)	(1.9139)	(1.7388)	(1.9009)
Aggl	-0.0009	-0.0018	-0.0009	-0.0017
	(0.7824)	(1.4973)	(0.7891)	(1.5217)
Gefav	-0.1261***	-0.1609***	-0.1261***	-0.1504***
	(3.7398)	(4.7116)	(3.8337)	(4.6073)
Cgov	-0.0048*	-0.0031	-0.0048*	-0.0029
	(1.8265)	(1.1923)	(1.7507)	(1.1601)
Transf	-0.0008	0.0011	-0.0008	0.0008
	(0.7558)	(1.0474)	(0.7998)	(0.7799)
Fed	-0.0497	-0.0827	-0.0497	-0.0839
	(0.9100)	(1.4944)	(1.0947)	(1.5866)
	Number of observations: 120			
	Number of cross-sections: 30			

Note: t-statistics are given in parentheses: *, **, *** significant at the 10%, 5% and 1% level respectively.

Table 2 also reveals, in line with the findings of e.g. Rodriguez-Pose and Ezcurra (2010), Lessmann (2011) and Ezcurra and Pascual (2008) that regional disparities tend to increase at higher levels of GDP per capita. Contrary to the findings of Rodriguez-Pose and Gill (2006),

the effects of trade on regional disparities, represented by the variable *Open*, apparently could not be demonstrated with the data set used here. The business cycle clearly affects spatial convergence favourably since the parameter of the variable *Gap* is significantly negative, at least in explaining disparities measured by the unweighted coefficient of variation *Rd*. This means that an upswing of the business cycle, reflected by a positive (overall) output gap, contributes to regional convergence. This finding implies that the most competitive regions will during this phase exert a positive pull effect on the poorer regions. The latter benefit during the later years of economic expansion from cheaper labour, less congestion and spare production capacity in contrast to the more developed regions that, in general, are more services oriented and less sensitive to a cyclical upswing. The absence of a significant impact of *Gap* on the weighted coefficient of variation *Wrd* needs further explanation. If the poorer regions catch up with the richer ones during a cyclical boom period and if it is assumed that the latter are more populated than the former, the weighted coefficient of variation will not fully mirror the ongoing spatial convergence in contrast to its unweighted counterpart. It may also be noted that the output gap variable is actually widely used in the study of business cycle effects, whereas unemployment statistics measure the derived and delayed effect of economic activity and are therefore less appropriate in spatial convergence studies.

The instrumental variable estimation reveals the significant contribution of the efficiency of governments (*Gefav*) to regional convergence, measured by *Rd* or *Wrd*. Cultural fragmentation leads, as was expected, to spatial inequality, measured by *Wrd*. The potential spatially equalising capacity of the central government, is confirmed by the significant negative sign of the parameter of *Cgov* when *Rd* is the relevant measure of regional disparities.

The estimation results of the interaction model confirm the convergence effect of tax autonomy. The coefficients of the *Tax* variable are now significantly negative. They imply that an increase of 1 percentage point of the revenue share of autonomous taxes, in the absence of infrastructure investment, contributes to regional convergence by only 0.003 percentage points. To state this impact differently: the SNG revenue share of autonomous taxes has to increase by 10 percentage points in order to result in a decrease of the coefficient of variation of GDP per capita by 0.03 percentage points (by .02 percentage points if *Wrd* applies) for regions that do not benefit from infrastructure investment. The convergence impact of infrastructure investment is more substantial: if its share in GDP is raised by 1 percentage point, independently of a change in autonomous taxes, the disparity measures decline by 0.04 to 0.05 percentage points respectively.

The marginal contribution to regional convergence, measured by *Rd,* of infrastructure investment- conditional on the degree of tax autonomy- can be derived as: - 0.039 +0.002 *Tax*, which is negative if the share of autonomous taxes is smaller than 19.5 percent. This cut-off value is substantially lower than the sample average of 26.6 percent. This condition holds for 12 of the 30 countries, among these are European transit economies such as Estonia, Poland and Slovenia and low income countries Chile and Mexico. Analogously, the conditional marginal impact of *Inv* when convergence is measured by the weighted coefficient of variation *Wrd* amounts to: - 0.052 + 0.002 *Tax*, implying a favourable effect of infrastructure investment on regional disparities if the revenue share of autonomous taxes is smaller than 26 percent. This cut-off value roughly corresponds to the sample average. The standard error of the interaction term at this cut-off point is 0.05 and decreases substantially at lower values of *Tax* (Brambor *et al*., 2006).

In the same way the marginal, conditional contribution to spatial convergence of tax autonomy is derived from the parameter estimates of *Tax* and *Tax x Inv* : -0.003 + 0.002 *Inv* when *Rd* figures as a disparity measure. The marginal impact of *Tax* implies that an increase of SNG tax autonomy favourably affects regional convergence as long as the investment share in GDP is smaller than 1.5 percent of GDP. This cut-off value applies to 21 of the 30 countries of the sample, among which are 19 of the 23 European countries that display a below-average investment rate. The overall sample average of *Inv* amounts to 0.97 per cent and implies a standard error of the interaction term of 0.001 that decreases at values of *Inv* smaller than 0.97 per cent. The marginal contribution of autonomous taxes to regional disparities, when reflected by *Wrd* and conditional on infrastructure investment, is (except for rounding errors) identical to the case where *Rd* is taken as the representative inequality measure.

Apparently, transport infrastructure investment positively contributes to regional convergence, particularly if the tax autonomy of the SNGs is relatively modest. This fiscal characteristic of the SNGs may impede substantial investment in socially profitable infrastructure projects. Below average fiscal autonomy and infrastructure investment rates are found in the federal countries Belgium, Germany and Mexico and in Estonia, Ireland, the Netherlands and the UK. In order to further regional convergence in the aforementioned federations, strengthening the subnational fiscal autonomy may allow the regions to embark on productive infrastructure investment projects. This constraint also holds for the SNGs of the four previously mentioned unitary countries. The fact that the infrastructure rate in these European countries is below average may reflect the presence of a substantial capital stock of transportation infrastructure that embodies past investment. In countries where the subnational fiscal autonomy substantially exceeds the sample average in contrast to the below sample average infrastructure investment rate, such as in Denmark, Finland, Sweden and the US, the social profitability constraint on new investment projects is, of course, a decisive criterion if the promotion of spatial equality is a major policy objective.

The other parameter estimates of the interaction model confirm the results of the model without interaction: welfare, reflected by GDP per capita, increases regional inequality and regional disparities, measured by *Rd* tend to diminish in cyclical boom periods. The decomposition of the country fixed effects indicate that more fragmented countries show more regional divergence and that government effectiveness promotes convergence. Countries where the expenditure share of the central government is important, can apparently better cope with spatial divergence in comparison with more decentralised nations. Federally organised countries show less divergence in comparison to unitary nations, judging from the negative sign of *Fed* with respect to the weighted coefficient of variation, although the statistical significance of the corresponding parameter estimate is somewhat smaller than 10 percent. Finally, transfer dependency of subnational governments and agglomeration economies do not significantly impact regional disparities.

4.2 The Effect of Subnational Expenditure Items on Convergence in 27 OECD Countries.

Table 3 presents the estimation results of equation (2) for 27 OECD countries for which data on the functional classification of subnational expenditures is available. In particular, the impact on convergence by expenditure on education and economic affairs is the primary focus. The exclusion of Canada, Chile and Mexico for which data on these subnational expenditures is missing, can also be conceived as a robustness test of the results obtained in Table 2, although

the significance of the estimates in Table 3 may be affected by the reduced number of degrees of freedom.

The most significant parameter estimates that are similar to the results of the first half of Table 2 are obtained in the explanation of the unweighted coefficient of variation *Rd*. The parameter estimates of *Tax, Inv, Tax x Inv , Log GDP* and *Gap* with respect to *Rd* all lie within a 95 percent confidence interval of the estimates in Table 2. This characteristic also holds for the parameter estimates of the same variables with respect to *Wrd,* although their statistical significance has decreased. The instrumental variables estimation with respect to *Wrd* confirm the negative influence on convergence of cultural fragmentation, in contrast to the positive impact on convergence of government effectiveness.

Table 3. Impact of tax autonomy, infrastructure investment and regional expenditure on disparities

Dep. Variable	Rd	Wrd
Tax	-0.0021***	-0.0019
	(3.2760)	(1.3135)
Inv	-0.0281**	-0.0493*
	(2.0223)	(1.7072)
Tax x Inv	0.0017***	0.0014
	(3.1561)	(1.0694)
Log GDP	0.1326**	0.1904
	(2.1733)	(1.5333)
Open	0.0006	0.0007
	(1.4901)	(0.7710)
Gap	-0.0019*	0.0001
	(1.6929)	(0.0474)
Constant	0.0580	0.0022
	(0.9374)	(0.0201)
R^2	0.9719	0.9307
Adjusted R^2	0.9598	0.9009
Instrumental variables estimation		
Frag	0.0889	0.1837**
	(0.5433)	(2.0315)
Aggl	-0.0005	-0.0010
	(0.3287)	(0.9692)
Gefav	-0.0484	-0.0807**
	(1.1565)	(2.4078)
Cgov	0.0011	0.0013
	(0.2267)	(0.5004)
Transf	-0.0008	0.0005
	(0.8865)	(0.5561)
Fed	-0.0289	-0.0906**
	(0.6162)	(2.0990)
Econ	0.0028	0.0008
	(0.6021)	(0.3154)
Educ	0.0044	0.0014
	(0.9031)	(0.6889)
	Number of observations: 104	
	Number of cross-sections: 26	

Note: t-statistics are given in parentheses: *, **, *** significant at the 10%, 5% and 1% level respectively.

A federal structure significantly contributes to a decrease of the weighted coefficient of variation. Finally, no significant convergence impact of subnational expenditure on education and on economic affairs could be found. This is in line with Rodriguez-Pose and Ezcurra (2010), who concluded that not only subnational expenditure on education and economic affairs, but also spending on health and housing were completely dissociated from regional disparities, at least in developed countries similar to those in the sample of 26 OECD countries studied in this paper.

5. CONCLUDING REMARKS

This paper analyses the link between fiscal decentralisation, infrastructure investment and regional disparities in 30 OECD countries over the period of 1995-2011. According to the "second generation fiscal federalism", fiscal decentralisation will induce the subnational governments of poorer regions to compete with their richer counterparts, thus narrowing regional income differences. Rodriguez-Pose and Ezcurra (2010) question this optimistic view and stress the conditional role of the economic environment in which fiscal decentralisation operates, this is in developing economies less favourable to the potential equalising impact of fiscal decentralisation.

In order to empirically test for the equalising effect of fiscal decentralisation, subnational tax autonomy, drawn from the OECD classification of subnational tax revenue, is introduced as a key explanatory variable of regional disparities, measured by the coefficient of variation and by its weighted counterpart. Transport infrastructure investment, viewed as a complement or a substitute for subnational tax autonomy in the framework of regional inequality, is introduced as an additional explanatory variable. Whereas tax autonomy refers to the virtues of the competition between SNGs, transport infrastructure investment generates positive externalities for some or all regions irrespective of the financing government, and it shares many characteristics with social goods.

A fixed-effects panel data estimation of the basic equation for 30 OECD countries over 4 time periods, with regional disparities as dependent variable, reveals that SNG tax autonomy significantly contributes to regional convergence although its impact remains modest relative to the effect of transport infrastructure investment. Furthermore, the interaction model shows that the convergence impact of transport infrastructure investment strengthens as subnational fiscal autonomy weakens. In this respect, below average subnational fiscal autonomy and transport infrastructure rates are found in the federal countries Belgium, Germany and Mexico and in the unitary countries Estonia, Ireland, the Netherlands and the UK. In order to foster regional convergence in the three federations, strengthening subnational fiscal autonomy may allow their regions to embark on socially profitable investment projects. As for the four mentioned unitary countries, only Estonia and Ireland show above average regional disparities and extremely low subnational i.e. local fiscal autonomy. These characteristics suggest, on the basis of the parameter estimates of the model, a substantial increase of local fiscal autonomy in order to mitigate spatial inequality. The empirical findings also reveal cyclical variations of regional disparities that are weakened during economic boom periods. Furthermore, in the line of findings in other empirical studies of the subject, cultural fragmentation intensifies spatial inequality in contrast to the convergence impact of government effectiveness. The empirical results of the estimation of the basic equation for 27 OECD countries confirm the findings for

the set of 30 countries, but could not detect an impact on regional disparities of subnational expenditures on education and economic affairs.

Further research on the topic would certainly benefit from detailed data on the financing of infrastructure investment in general, whether by SNGS, by the central government or by both.

NOTES

1. In addition to autonomous tax revenue and transfers from other governments, taxes shared with the central government, property income and user fees are the main components of subnational government revenue.

REFERENCES

Alesina A., Devleesschauwer A., Easterly W., Kurlat S., Wacziarg R., 2002. Fractionalization. Working Paper Series No. 9411, National Bureau of Economic Research, Cambridge, Massachusetts.

Barro R.J., 1991. Economic growth in a cross-Section of countries. *The Quarterly Journal of Economics,* 106, No 2, 407-443.

Barro R.J. and Sala-i-Martin X. 1992. Convergence. *Journal of Political Economy*, 100, (2), 223-251.

Blöchliger H. and Kim J. (Eds.) 2016 Fiscal federalism 2016. Making decentralisation work. *Organisation for Economic Co-operation and Development (OECD*), Paris.

Brambor T. , Roberts Clark W. and Golder M. 2006. Understanding interaction models: Improving empirical analysis. *Political Analysis,* 13, 1-20.

Calamai L. 2009. The link between devolution and regional disparities. *Environment and Planning A* (41), 1129-1151.

Chatelain J. and Ralf K. 2010. Inference on time-invariant variables using panel data: a pre-test estimator with an application to the returns on schooling. *Working Paper*. University of Paris and Centre pour la Recherche économique et ses Applications (CEPREMAP), Paris.

Cheshire P. and Magrini S. 2000. Endogenous processes in European regional growth. *Growth and Change,* 31 (4), 455-479.

Barro R.J. 1991. Economic Growth in a cross-section of countries. *The Quarterly Journal of Economics,* 106 No 2, 407-443.

Barro R.J. and Sala-i-Martin X. 1992. Convergence. *Journal of Political Economy,* 100 (2), 223-251.

Calderon C. and Servén L. 2010. Infrastructure in Latin America. *Policy Research Paper,* No.5317, The World Bank, Washington D.C.

Cowell F.A. and Jenkins S.P. 1995. How much inequality can we explain? A methodology and an application to the United States. *The Economic Journal*,105,421-430.

Ezcurra R. and Pascual P. 2008. Fiscal decentralization and regional disparities: Evidence from several European countries. *Environment and Planning A* (40), 1185-1201.

Gardiner B. , Martin R. and Tyler P. 2010. Does spatial agglomeration increase national growth? Some Evidence from Europe. *Journal of Economic Geography*, (11), 1-28.

Geppert K. and Andreas S. 2008. Regional disparities in the European Union: convergence and agglomeration. *Papers in Regional Science*, (87) No.2, 193-217.

Giannetti M. 2002. The effects of integration on regional disparities: convergence, divergence or both. *European Economic Review*, 46 (3), 539-567.

Greene W.H. 2012. *Econometric Analysis*, 7th Edition, Pearson, London.

Hausman J. 1978. Specification tests in econometrics. *Econometrica*, 46, 1251-1271.

Hausman J. and Taylor W. 1981. Panel data and unobservable individual effects. *Econometrica,* 49, 1377-1398.

Hines J.R. 1996. Taxes and the location of foreign direct investment. *American Economic Review,* 86, No 5, 1076-1094.

Kappeler A. , Sollé-Ollé A., Stephan A. and Välilä T. 2013. Does fiscal decentralization foster regional investment in productive infrastructure? *European Journal of Political Economy*, 31, 15-25.

Kaufmann D., Kraay A. and Mastruzzi M. 2009. Governance matters VIII-Aggregate and individual governance indicators 1996-2008. *Policy Research Working Paper*, The World Bank, Washington D.C.

Kelejian H. and Robinson D.P. 1997. Infrastructure productivity estimation and its underlying econometric specification: a sensitivity analysis. *Papers in Regional Science* 76, 115-131.

Kessler A.S. and Lessmann Ch. 2010. Interregional redistribution and regional disparities: how equalization does (not) work. *CEPR Discussion Paper No. 813.* Centre for Economic Policy Research, London.

Kyriacou A.P., Muinelo-Gallo L. and Roca-Sagalés O. 2015. Regional inequalities, fiscal decentralization and government quality: empirical evidence from simultaneous equations. *GEN Working Paper A*, 2015-1, Universidad de Vigo, Vigo .

Lessmann Ch. 2006. Fiscal decentralization and regional disparity: a panel data approach for OECD countries. *IFO Working Paper Series* No. 25, IFO Institute, Munich.

Lessmann Ch. 2011. Spatial inequality and development- is there an inverted-u relationship? *CESIFO Working Paper* No. 3622, CESIFO, Munich.

Lessmann Ch.. 2011. Regional inequality and decentralization: an empirical analysis. *Environment and Planning A,* 44 (6), 1363-1388.

Magrini S., Geralimetto M. and Duran H.E. 2013. Regional convergence and aggregate business cycle in the United States. *Regional Studies,* 49, 251-272.

Martin R. and Sunley P. 1998. Slow convergence? The new endogenous growth theory and regional development. *Economic Geography,* 74 (13) ,201-227.

Martinez-Vazquez J. and McNab R. 2003. Fiscal decentralization and economic growth. *World Development,* 31 (9), 1597-1616.

Musgrave R. 1959. *The Theory of Public Finance*. McGraw Hill, New York.

Oates W.E. 1972. *Fiscal Federalism*. Harcourt Brace Jovanovich, New York.

Oates W.E. .2006. On the theory and practice of fiscal decentralization. *Working Papers 2006-2005*. Institute for Federalism and Intergovernmental Relations, University of Kentucky, Lexington.

Organisation for Economic Cooperation and Development (OECD) 2002. *Impact of Transport Infrastructure Investment on Regional Development*, Paris.

Qian Y. and Weingast B. 1997. Federalism as a commitment to preserving market incentives. *Journal of Economic Perspectives,* 11 (4), 83-92.

Rodriguez-Pose A. and Gill N. 2006. How does trade affect regional disparities?. *World Development,* 34 (7), 1201-1222.

Rodriguez-Pose A. and Kroijer A. 2009. Fiscal decentralization and economic growth in Central and Eastern Europe. *Growth and Change,* 40 (3), 387-417.

Rodriguez-Pose A. and Ezcurra R. 2010. Does decentralization matter for regional disparities? A cross-country analysis. *Journal of Economic Geography,* 10 (5), 619-644.

Sorens J. 2014. Does fiscal federalism promote regional inequality? An empirical analysis of the OECD, 1980-2005. *Regional Studies,* 48 (2), 239-253.

Stegarescu D. 2005. Public sector decentralization: measurement concepts and recent international trends. *Fiscal Studies,* 26, 301-333.

Tanzi V. 1996. Fiscal decentralization: A review of some efficiency and macroeconomic aspects. In M. Bruno and B. Pleskovic (Eds.), *Annual World Bank Conference on Economic Development*, 539-567, The World Bank, Washington D.C.

Thomas M.A. 2010. What do worldwide governance indicators measure? *European Journal of Development Research*, (22), Issue 1, 31-54.

Tiebout Ch. M. 1956. A pure theory of local expenditures. *The Journal of Political Economy,* 64 (5), 416-424.

Uchida H. and Nelson A. 2008. Agglomeration index: towards a new measure of urban concentration. *World Development Report. Background Paper*, The World Bank Washington, D.C.

Weingast B.R. 1995. The economic role of political institutions: Market–Preserving federalism and economic development. *Journal of Law, Economics and Organization*, Spring (11), 1-31.

Weingast B.R. 2014. Second generation fiscal federalism: Political aspects of decentralization and economic development. *World Development* 53 (C), 14-25.

Wei Shang-Jin and Wu Y. 2001. Globalization and inequality: evidence from within China. *NBER Working Paper* No. 8611, National Bureau of Economic Research, Cambridge, Massachusetts.

Appendix table 1. Descriptive statistics of key variables

Variable	Mean	Standard deviation	Minimum	Maximum
Rd	0.269	0.105	0.110	0.530
Wrd	0.275	0.123	0.070	0.640**
Tax	26.594	17.727	0.000*	64.300
Inv	0.973	0.432	0.300	2.200
Log GDP	1.399	0.202	0.815	1.767
Gap	0.146	1.898	-4.700	7.200
Open	81.817	36.338	20.000	165.000

*: Ireland (1995-2011)

**: Mexico (2005-2011)

Appendix table 2. Correlation matrix of time-varying variables

	Rd	Wrd	Tax	Inv	Log GDP	Gap	Open
Rd	1.000						
Wrd	0.753	1.000					
Tax	-0.162	-0.360	1.000				
Inv	-0.011	-0.135	-0.042	1.000			
Log GDP	-0.587	-0.626	0.412	-0.156	1.000		
Gap	0.038	0.091	-0.036	0.009	0.096	1.000	
Open	0.340	0.436	-0.178	-0.028	-0.135	0.188	1.000

Appendix table 3. Definition and source of variables

Variable	Definition	Date Source
(a) Time – varying variables		
Rd	Coefficient of variation of regional GDP per capita; 5-year averages (1995-2011)	OECD Regional database
Wrd	Population-weighted coefficient of variation of GDP per capita; 5-year averages (1995-2011)	OECD Regional database
Tax	Share of autonomous taxes in consolidated own revenue of state and local governments (averages 1995-02, 02-05, 05-08, 08-11)	OECD Fiscal decentralization database – Table 1. (1) (2)
Inv	Ratio of transport infrastructure investment and maintenance spending to GDP (5-year averages 1995-2012)	OECD Infrastructure investment database
GDP	Real GDP per head (5-year averages 1995-2011	OECD Regional database – Regional accounts
Gap	Annual output gap: 5-year averages 1995-2011	OECD Economic outlook
Open	Exports of goods and services (%GDP); 5-year averages 1995-2011)	The World Bank
(b) Time – invariant variables		
Frag	Index of ethnic fragmentation (variable years 1983-01)	Alesina et al. (2002)
Aggl	Measure of urban concentration – agglomeration index (b) – year 2000	Uchida et al. (2008)
Gefav	Index of government effectiveness – average 1996-2011	The World Bank
Cgov	Share of central government expenditure in total government expenditure – 2003 data	OECD Economic outlook
Transf	Share of subnational transfer revenue in total subnational revenue. Average 1995-2011	OECD Decentralization database
Fed	Federal dummy variable	

(1) For federal countries Tax is a weighted average of the regional and local tax autonomy indicator (the weights are the respective revenue shares).

(2) For Australia, Chile and Japan: tax and total subnational revenue were obtained from the IMF Government Finance Statistics, the OECD Fiscal Decentralization Database and from the respective National Statistics Offices.