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Abstract

In this study I use improved data of fiscal decentralization to re-examine the hypothesis that shifts towards more fiscal decentralization would be accompanied by improvements in population health on a panel of 19 OECD countries. The advantage of the new measure of decentralization is that it reflects better than previous measures the existence of autonomy in the decision making authority of lower tiers of government, a crucial issue in the decentralization process. The results based on panel data estimation techniques robust to heteroskedasticity and autocorrelation show that fiscal decentralization has a substantial and positive effect on health outcomes over the period studied. However, I find that conventional measures of decentralization tend to over-estimate the magnitude of the effect.

JEL Classification: I12, H77.

Key words: Fiscal decentralization, health outcomes, OECD countries, panel data

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1. Introduction

Despite the large number of countries worldwide that are increasingly devolving responsibilities for their health care systems to local levels of government, there is insufficient evidence about the potential impact of such reforms. To date much of the literature on this topic has concentrated on theoretical discussions about the potential advantages and disadvantages of transferring decision making and economic resources from central to local levels of government.

However, in absence of quantitative measures of the magnitude of the effect of decentralization[1], there is little that can be said in terms of its benefits and its costs to the health system. The most appropriate level of decentralization of health services is therefore a central policy issue that to date remains largely unresolved.

Many of the proponents of decentralization claim that decentralization could strengthen accountability of policy makers to local electors and transparency, thus allowing a better tailoring between the provision of goods and services and local needs (Oates, 1999). With respect to the health services in particular, decentralization is expected to improve access to health care services, and ultimately, population health (Robalino, Picazo & Voetberg, 2001; Uchimura & Jütting, 2009; Khaleghian, 2004).

However, in spite of the identified advantages of devolution of policy making in health care services, there is limited empirical evidence about the impact of this intervention on population health. One of the main reasons for this is that much of the existing literature focuses on case studies or on middle and low income countries. In addition, current studies on decentralization and health outcomes have generally relied on fiscal data from the Government Financial

[1] In this study decentralization is synonymous with devolution, a political reform designed to promote autonomy at the local level. See Hunter, Vienonen and Cezary (1998, p.311-3) for a detailed classification of the different types of decentralization, namely deconcentration, delegation, and devolution.

Statistics (GFS) of the International Monetary Fund (IMF). While providing a consistent dataset across countries and over time, decentralization measures based on data from the GFS fail to properly reflect the level of autonomy in policy making of sub national tiers of government (Ebel &Yilmaz, 2004, Rodden 2003).

The main objective of this paper is to use empirical analysis to inform the debate about the most appropriate degree of decentralization of the health system. This study contributes to the research literature by using an improved fiscal decentralization indicator on a panel of 19 OECD countries to test the extended hypothesis in the research literature that more decentralization leads to better health outcomes. The next section discusses the theoretical considerations to understand how decentralization could influence population health. Section three presents an overview of the current evidence on the impact of decentralization on health outcomes. Section four describes the new data on fiscal decentralization, while section five presents the empirical specification used to model the relationship between decentralization and health status and the data and variables employed in this study. In section six the results are shown and section seven concludes.

2. Theoretical framework: the impact of decentralization on health outcomes

Decentralization is argued to assign more financial responsibility for health service provision to lower tiers of government bringing about efficient service provision (Khaleghian, 2004, Uchimura, and Jutting (2010), Robalino (2001)). The beneficial impact of decentralization on health services is based on the assumptions that decentralization can improve the information of local decision makers about local circumstances, stimulating prompt and effective responses to local needs, and is an effective channel for people to express their preferences. Local decision makers also have more opportunities to reduce costs than central managers. They can tailor staff and procedures to the local context, and have more freedom for experimenting with alternative ways of doing things and implementing them rather than relying on centrally determined procedures. Therefore, decentralization, if properly designed and

implemented, is expected to improve equity, efficiency, quality, and access to health care services and ultimately health outcomes.

Implicit in the above arguments is the assumption that policy makers are responsive for the provision of health services and are able to manage financial resources efficiently. While intergovernmental fiscal transfers may be required on equity grounds to compensate for different revenue capacities at the local level, there is a risk that too much reliance on grants places little pressure on local governments to manage spending efficiently (Oates,1993). In fact, a common finding in the research literature is that local spending is much more responsive to increases in intergovernmental transfers than to equal increases in private income (see e.g. Fiva, 2005), a phenomenon which has become known as the *flypaper effect*.

Potential gains to be realised from decentralization are also conditional on the existence of decentralization of political decision-making authority, and in particular, effective channels for the individuals to express their preferences, and incentives for the policymakers to respond to those preferences. For this reason many authors are sceptical about the successful implementation of decentralisation in less developing countries, given their weaker administrative capacity and their lower initial levels of democracy as compared to developed countries (Khaleghian, 2004).

In spite of the compelling theoretical arguments put forward for devolution of policy making in health services, decentralization is not without its limitations (Gravelle, 2003; Khaleghian, 2004). Regarding economies of scale, decentralization might generate inefficient location of facilities such as hospitals by local decision makers accountable to local electors. Central intervention in health care is also expected to result in more efficient pricing of inputs by a single purchaser of health care. Decentralization of health services with important externalities, such as immunization services, is expected to encourage local jurisdictions to “free-ride” on the immunization status of their neighbours. The result could be a sub optimal disease protection level provided in the country as a whole. Finally, unless the central

government coordinates an adequate transfer mechanism from richer to poorer regions, decentralization may result in increased inequalities in health care if local authorities, under pressures to raise their own revenues rely on user fees to finance their services or reduce the coverage of the universal health package.

3. Empirical evidence on the impact of fiscal decentralization on health outcomes

In recent years a growing number of studies have investigated the impact of decentralization on various measures of population's health such as infant mortality, life expectancy or immunisation coverage rates. Table 1 summarizes the main results of these studies. Overall, most of the literature finds a beneficial impact of decentralization on indicators of population's health.

Mahal et al. (2000) use data from rural villages in India for 1994 to test the hypothesis that decentralisation has a positive influence on child mortality once the effect of socio economic factors, civil society organisations, and so on, are controlled for. They have used dummy variables for states that have significantly moved towards decentralisation during the period 1970-94, and the frequency of local body elections during the same period as proxies for decentralization. While the estimated coefficients for decentralized states have the expected positive effect, the election frequency variable is statistically insignificant. The study by Asfaw et al. (2004) corroborates the previous results for rural India using an index of fiscal decentralization obtained by factor analysis[2] on the basis of three variables[3] for the period

[2] Factor analysis is a statistical technique that can be used to summarise a set of correlated variables into a single measure.

3 These are: the share of local (rural) expenditure to the total state (intermediate government tier) expenditure, the total local expenditure per rural population, and the share of local own revenue from the total local expenditure.

1990-1997. Their results also show that the effectiveness of fiscal decentralization increases with the level of political decentralization[4].

The study by Habibi el al. (2003) shows that the percent of revenue raised locally and the proportion of controlled revenue over the total have a negative and significant association with infant mortality rates for a panel of Argentinean provinces over the period 1970-1994. In addition, the authors find that during the period of decentralization reforms studied, regional inequalities were considerably reduced.

In the study by Robalino et al., (2001) using a panel data of low and high income countries fiscal decentralization (measured as the proportion of sub national government expenditure over the total) is found to be inversely related to infant mortality rates during the period 1970-1995. Interestingly, according to the results the marginal benefit from decentralization is greater at low income levels. Also, in Yee (2001) the results of the fixed effects and random effects estimations for a panel data of Chinese provinces over the period 1980-1993 suggest that fiscal decentralization —proxied as the ratio of local government expenditure to central government expenditure, and the ratio of local government expenditure to total government expenditure- has been beneficial to the health sector in terms of reducing mortality rates and increasing local expenditure on health care.

In the recent study by Uchimura and Jütting (2009) two measures of fiscal decentralization of Chinese counties based on the counties' expenditures and revenues were found to be significantly associated with lower infant mortality between 1995 and 2001. Finally, the recent papers by Cantarero and Pascual (2008) and Jiménez-Rubio (2010) also find an inverse relationship between fiscal decentralization, measured as the ratio of sub national health spending over the total, and health outcomes in the Spanish regions and the Canadian provinces, respectively.

[4] Political decentralization is measured by an index constructed on the basis of factorial analysis from total voter's turnout, women's participation in polls and the number of polling stations per elector in each state.

A few other studies such as Ebel and Yilmaz (2002) and Khaleghian (2004) concentrate on the relationship between decentralization and immunization coverage rates. The intervention analysis by Ebel and Yilmaz shows a positive association between decentralization and the coverage of children under 12 months of age immunised for measles in six developing countries over the period 1970-1999.

Khaleghian (2004) examines the association between decentralization and immunisation coverage rates for the third vaccine against diphtheria, pertussis and tetanus (DPT3) and measles of children at one year of age in 140 low and middle income countries during the period 1980-1997. The main indicator of fiscal decentralization used in this study is a binary variable defined as the presence of taxing, spending, or regulatory authority on the part of sub national authorities. Two other decentralization indicators were used to double check the results: the share of sub national expenditures on total government expenditures, and the share of health spending on total sub national expenditures. The model also included several control variables (GDP per capita, illiteracy rate, democracy score, ethnic tension, etc). The findings suggest that decentralization improves coverage rates only in low-income countries[5].

Ebel and Yilmaz (2001) employ an intervention analysis[6] to evaluate the outcomes of decentralization in terms of immunisation rates for DPT and measles of children under 12 months in six developing countries (Argentina, Brazil, Colombia, Philippines, South Africa and Venezuela) during the period 1970-1999. The results of the estimated fixed effects model suggest that

[5] Contrary to the expectations (see p.4), in both Ebel and Yilmaz's and Khalegian's studies, a positive association between decentralization and immunization coverage rates is found on their sample of developing countries. Khaleghian (2004, p.176) has pointed out that this finding "may reflect a salutary balance between the proximity of local authorities to the community, and the preservation of central influence and bureaucratic autonomy, both of which are essential to the effective functioning of an immunisation program".

[6] An intervention analysis involves a test of the change in the mean of a variable as a result of a policy reform.

intervention by sub national governments has associated with an increase in the coverage of children immunised for measles.

Current evidence on the impact of decentralization in health care is however limited by the following reasons. Firstly, only a few of studies focus on developed countries. Secondly, by relying on IMF GFS fiscal data much of the literature fails to properly capture the actual level of decentralization in public policy making. The existing evidence is therefore insufficient to draw firm conclusions about whether countries with more decentralised health care systems have better health outcome.

4. Measuring fiscal decentralization: new indicator of sub-national tax autonomy

As shown in the previous section, most of the existing empirical studies on the relationship between decentralization and health outcomes have used indicators of decentralization derived from fiscal data. The level of decentralization in policy making is however a complex phenomenon embracing a number political, fiscal and administrative dimensions, many of which are not easy to measure empirically (Banting and Corbett, 2002). Therefore, an accurate measure of fiscal decentralization should be able to capture considerations other than purely fiscal ones such as political autonomy (e.g. range of services to be covered, access conditions), or the legal and regulatory structure (e.g. service standards, training regulations). However, in the absence of more appropriate measures of decentralization, fiscal decentralization indicators have been widely used in the research literature following Oates' seminal work in 1972. The most commonly used dataset to generate these measures has been the International Monetary Fund's (IMF) Government Finance Statistics (GFS).

While providing a consistent dataset across countries and over time, decentralization measures based on data from the GFS are likely to provide a misleading picture of the real level of autonomy in policy making of sub national tiers of government (Ebel &Yilmaz, 2002, Rodden 2003).

This is because GFS's local spending statistics include not only expenditures in functions controlled exclusively by the local jurisdictions, but also expenditures in functions controlled by higher levels of government (through directives, conditional grants, etc.). On the revenue side, the GFS classifies shared taxes, piggybacked taxes, and taxes in which the tax rate and/or base are decided by the central government as sub national own-source revenue.

In 1999, a report by the OECD improved the fiscal information available for a 19 countries by grouping taxes according to the level of discretion entitled to local governments. This classification ranges from a.) where the central government can set both the rate of taxation and the tax base, to e.) where sub national governments set both the tax base and the tax rate. Tax sharing agreements are further arranged into four categories from d.1.) where the sub national governments can determine the revenue split to d.4.) where the national government can unilaterally determine the revenue split.

Drawing on this classification, Stegarescu (2005) extended the OECD dataset to cover 23 countries from 1965 to 2001, and provided information on the level of autonomy over taxes by local governments relative to the general government. Stegarescu's indicator of decentralization therefore measures the share of local government taxes over the general government but only considers those taxes where the local government controls the tax rate, the tax base, or both. This data represents a major improvement for measuring decentralization in policy making compared to conventional indicators of fiscal decentralization based on IMF GFS data. Moreover, in contrast to dichotomous indicators of decentralization or federalism, fiscal data reflect the degree of the decentralization process[7]. Table 2 presents a summary of the advantages and disadvantages of the main fiscal decentralization indicators.

Our study contributes to the existing literature by empirically re-examining the hypothesis that more decentralization leads to an improvement in

[7] An example of this type of decentralization measures is the binary variable used by Khaleghian (2004) that represents the presence of taxing, spending or regulatory authority on the part of sub national governments.

population health using the improved measure of tax revenue decentralization (*AutTaxRevDec*). Also, contrary to much of the existing literature, we provide evidence on the impact of decentralization on health outcomes based on a set of developed countries.

Finally, we compare the results with those using the most common indicator of fiscal decentralization in the research literature: the share of sub national spending over the spending by the general government (*ExpDec*).

According to Table 3 countries are generally more decentralized in the expenditure than in the revenue side. Although the evolution of (autonomous) tax and expenditure decentralization show a similar trend over the period studied, there are a few exceptions. For instance, in this period both Austria and Canada show a reduction in the degree of autonomous tax decentralization and an increase in the degree of expenditure decentralization, while Japan, the Netherlands and Sweden show the opposite trend, that is, an increase in expenditure decentralization and a decrease in autonomous tax decentralization.

With respect to AutTaxRevDec, the preferred measure of fiscal decentralization, a trend towards increasing fiscal powers of sub national governments can be observed in Spain, Italy, Belgium, Denmark, Sweden, and Japan (see Figure 1). Switzerland, New Zealand, Ireland, United Kingdom, and Norway have experienced a reduction in the level of sub national fiscal autonomy, while the remaining countries, many of which are traditional federal countries, have shown a fairly stable degree of fiscal decentralization over the period of study (see Figures 2 and 3). According to Stegarescu (2005), AutTaxRevDec is a reliable indicator that reflects well the institutional changes that have taken place in these countries over the 30 years of study.

5. Estimation techniques

5.1 Basic model

In order to model the relationship between decentralization and health outcomes we use a panel data of 19 OECD countries from 1965 to 2001. The estimations are based on the following health production function based on previous studies (e.g. Uchimura and Jutting (2009), Or (2005)):

$$H_{ij} = \alpha_i + \beta X_{ij} + \delta Z_{ij} + \varepsilon_{ij} \qquad (1)$$

where *i* denotes time, *j* denotes country, *H* denotes health status, *X* denotes the fiscal decentralization indicator used, and *Z* denotes a vector of control variables employed in the estimations. We have used infant mortality rates from the OECD Statistics as the measure of health status. Infant mortality has been considered as the single most exhaustive indicator of health in a society. It reflects child's health and pregnant women's health, in addition to the state of health development within the society. Moreover, infant mortality is assumed to be more sensitive to policy changes such as decentralization than other health indicators such as life expectancy. In addition to the level of fiscal decentralization, control variables include the level of medical care inputs and other non-medical characteristics (Or, 2001; Or, Wang & Jamison, 2005). To measure the level of medical care inputs across OECD countries we use the number of doctors per 1000 population.

Non-medical determinants of health include the income level as measured by the GDP per capita, the educational level, and the consumption of alcohol and tobacco as life style indicators. Alcohol and tobacco are well known risk factors for health and are expected to have a negative impact on health outcomes. However, the level of education and income are expected to have a positive impact on health. This is because wealthier and better educated people are expected to select, for example, healthier diets or better jobs than less wealthier and less educated individuals.

5.2 Data and econometric methods

Data were taken from various sources. The main fiscal decentralization measure, the share of autonomous tax revenue of local government over the general government tax revenue, is obtained from Dan Stegarescu's dataset (2005). The alternative fiscal decentralization indicator employed, the share of local government spending over the total spending for all levels of government, is obtained from the International Monetary Fund's Government Finance Statistics. Data on infant mortality, the dependent variable, GDP per capita, alcohol and tobacco consumption were taken from the OECD.Stat Extracts. Finally, the level of education was obtained from the Centre for Economic Performance-OECD Political Institutions dataset 1960-2004 (Nickell, 2006). Table 4 in the Appendix presents descriptive statistics and definitions of the variables used in the estimations.

The empirical specification to explore the impact of decentralization in health outcomes is based on OLS Panel Corrected Standard Errors (PCSE) (Prais & Winsten, 1954). PCSE deal with several common problems of panel data: autocorrelation (the errors within a unit are serially correlated), cross sectional correlation (the errors of various units are correlated), and heteroscedasticity (the variance of the errors is not constant). Time and country specific dummy variables are included in the analysis to control for time invariant characteristics of the population and the possibility of period specific shocks (i.e. variations in tax shares) respectively. Finally, we explore the robustness of the results to alternative specifications such as Feasible Generalized Least Squared (FGLS) and Newey-West OLS estimation techniques robust to heteroskedasticity and autocorrelation.

6. Results

Table 5 displays the results. Two different versions of the health outcomes equation presented in section four were estimated, one for each fiscal decentralization indicator considered in this study. The model that uses Stegarescu's improved measure of fiscal decentralization provides us with the benchmark results (first column of Table 5). However, we also fit an alternative specification using a more conventional measure of fiscal

decentralization based on expenditure data for comparative purposes (second column of Table 5).

Both the time and year dummies turn out to be statistically significant and are included throughout the analysis (p values for both F tests of zero coefficient parameters show a rejection of the null hypothesis at any conventional significance level). The Wooldridge test and the modified Wald test for panel data show evidence of autocorrelation and heteroskedasticity (p-values = 0,00), while according to the Breusch Pagan test the null hypothesis of cross sectional independence cannot be rejected at any conventional significance level (p value = 0,44). The standard errors of the model shown in Table 5 are therefore robust to heteroskedasticity and autocorrelation. The two alternative econometric specifications fitted (FGLS and OLS with Newey standard errors) also control for autocorrelation and heteroscedasticity. The results of these models, shown in Tables 6 and 7, are very similar in magnitude and sign to those using PCSE. As an additional robustness check, we excluded from the analysis countries with a stable trend. Again, the results of the estimated models were very similar to those pooling all the countries together.

According to the findings there is a negative and significant relationship between *AutTaxRevDec*, the key independent variable, and infant mortality on the 19 OECD countries analysed over the period of study. On average, it is estimated that a 1% increase in the proportion of autonomous tax revenue controlled by local governments leads to a 0,05 per cent reduction in infant mortality[8]. The same result is observed in the second specification, where the decentralization variable is the share of total expenditure controlled by sub national government (*ExpDec*). However, the magnitude of the effect in this case is almost four times larger: a 1 per cent increase in expenditure decentralization is associated with approximately a 0,2 per cent reduction in infant mortality.

[8] As indicated in Tables 5, 6 and 7 variables are defined in logs. The coefficients of the variables can be easily interpreted as elasticity by a log transformation (see e.g. Filmer and Pritchett, 1999).

Variables other than decentralization seem to have had a greater impact on infant mortality in our sample of OECD countries over the three decades of study. The effect of education is particularly important: the two specifications of the model shown in Table 5 predict that, on average, a 1 per cent increase in education stimulates roughly a 0,2 per cent reduction in infant mortality. The estimations also show an inverse relationship between the number of doctors and infant mortality. Both of these results corroborate the findings of previous research based on a similar cross-sectional sample of OECD countries (Or, Wang and Jamison, 2005) and contribute to the ongoing debate on the effects of the medical care system on population health (Filmer and Pitchett, 1999; Or, 2000).

7. Conclusions

The theoretical literature of fiscal federalism applied to health economics predicts potential efficiency gains (improvement of the population's health) from placing responsibilities of local public goods at the local level. However, in spite of the identified advantages of devolution of policy making in health care services, there is limited empirical evidence about the impact of decentralization on population health. This is due to the fact that much of the existing literature focuses on case studies or on middle and low income countries. In addition, many of the existing studies on decentralization and health outcomes have used fiscal measures derived from the GFS of the IMF that does not reflect the real level of autonomy of local decision making (Ebel &Yilmaz, 2004, Rodden 2003).

This paper contributes to the research literature by using an improved fiscal decentralization indicator constructed by Stegarescu in 2005 on a panel of 19 OECD countries to test the common hypothesis in the research literature that more decentralization leads to improved health outcomes. Stegarescu's indicator of decentralization measures the share of local government taxes over the general government but only considers those taxes where the local government controls the tax rate, the tax base, or both. This data represents a major improvement for measuring decentralization in policy making

compared to more conventional indicators of fiscal decentralization based on IMF GFS data. We have also compared the results using our improved measure of fiscal decentralization with those using an alternative measure of fiscal decentralization widely used in the research literature: the share of sub national spending over the spending by the general government (based on data from the GFS of the IMF).

The results of the econometric estimations for these 19 OECD countries suggest that decentralization has had a positive and substantial influence on the effectiveness of public policy in improving population's health (in terms of a reduction in infant mortality rates). Our findings also suggest that conventional measures of decentralization may overestimate the magnitude of the effect. Measures that adequately reflect the level of autonomy in local decision making are therefore necessary to capture the true impact of decentralization in future research.

Some caution is required in interpreting the results of this study. First of all, because this paper only analyses one of the multiple dimensions of decentralization: the fiscal one. While decentralization is a complex phenomenon, to date there is no single measure that captures all the multiple dimensions of the decentralization process. Secondly, although the measure of health outcomes employed (infant mortality) is superior to alternative indicators such as life expectancy, it does not fully reflect the underlying level of health in a society. In spite of these limitations, this research adds new empirical evidence in the evaluation of the economic gains arising from decentralization in health care in a selected group of OECD countries.

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Figures

Figure 1: Evolution of Autonomous Tax Revenue Decentralization: countries with an upwards trend

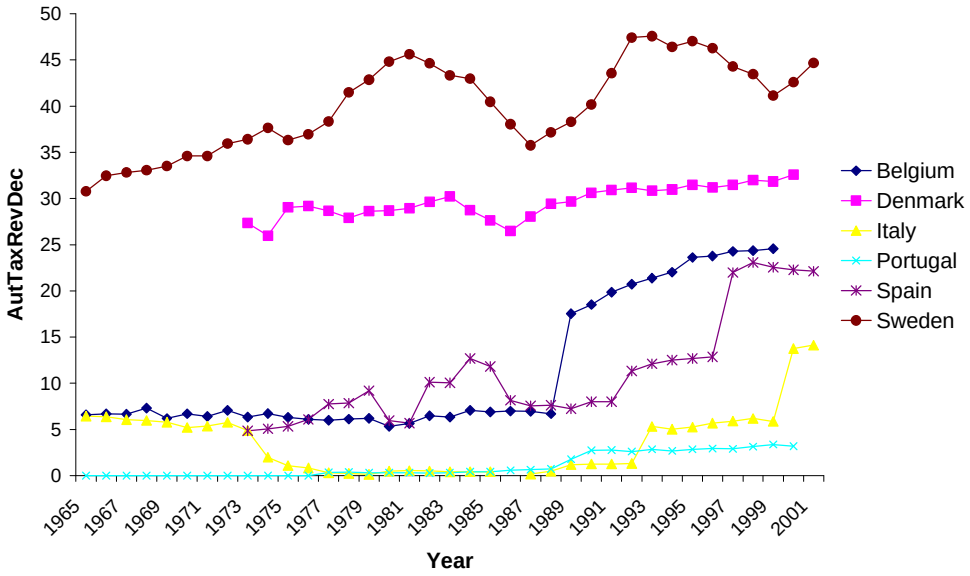


Figure 2: Evolution of Autonomous Tax Revenue Decentralization: countries with a downwards trend

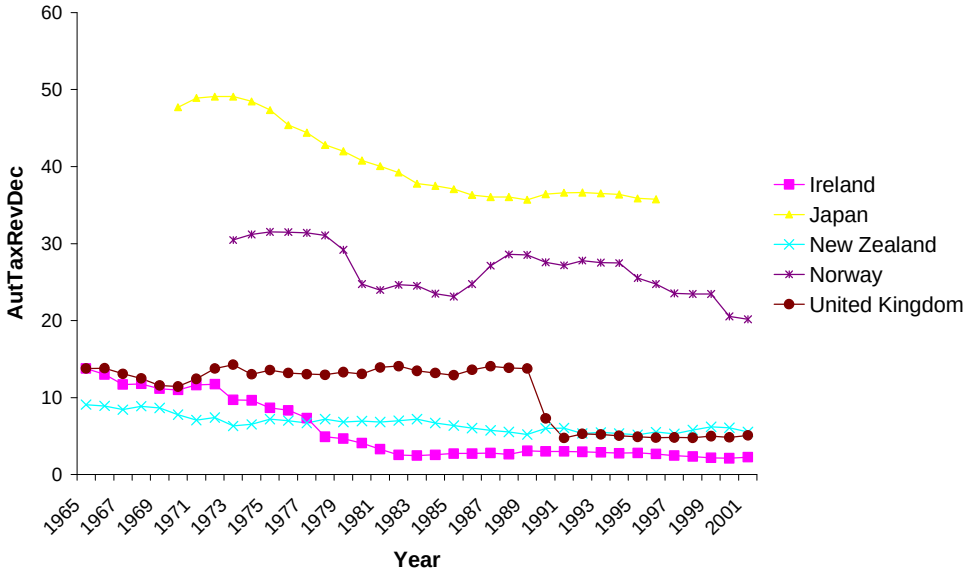
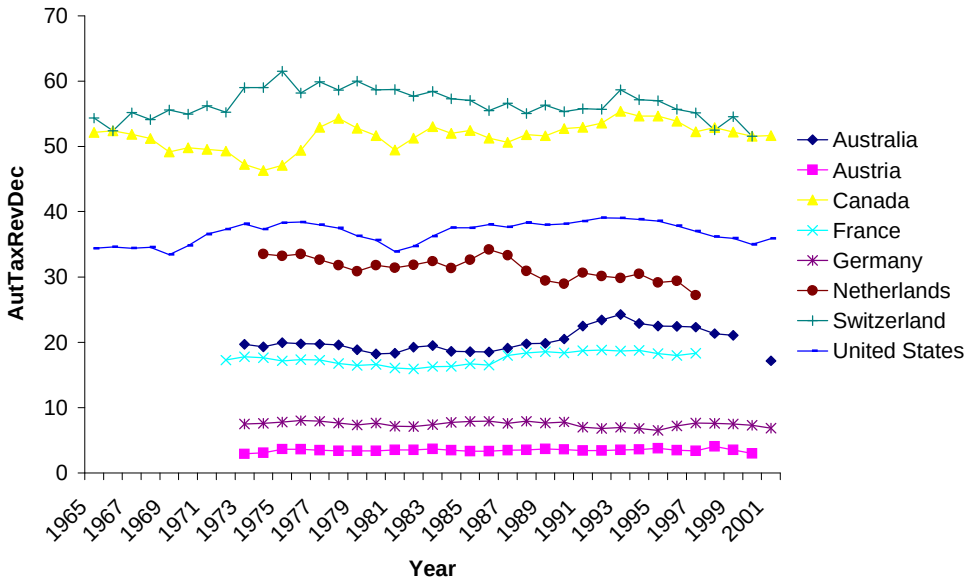


Figure 3: Evolution of Autonomous Tax Revenue Decentralization: countries with a stable trend



Tables

Table 1. Summary of previous studies on the impact of decentralization on health outcomes

Reference	Area of study	Period of study	Model description	Main results
Asfaw et al (2007)	Rural villages in India	1990-1997	Panel data specification where decentralization is proxied by an index of fiscal decentralization obtained by factor analysis on the basis of three variables (the share of local (rural) expenditure on total state (intermediate government tier) expenditure, the total local expenditure per rural population, and the share of local own revenue from the total local expenditure). Other relevant determinants of infant mortality included in the analysis are: women literacy, per capita income and an index of political decentralization constructed from a number of variables using factor analysis (total voters' turnout, women's participation in polls, and the number of polling stations per electors in each state).	This study suggests that fiscal decentralization can help to reduce infant mortality rates and political decentralization is a potential factor that can affect its effectiveness.
Cantarero and Pascual (2008)	15 Spanish regions	1992-2003	Panel data specification (fixed effects and random effects model) with infant mortality and life expectancy as dependent variables. The key indicator of decentralization is the ratio of sub-national health care expenditure to the total health expenditure for all the levels of government. Other control variables included in the model are: per capita income, per capita acute care beds (density per 1,000 population), and general practitioners (density per 1,000 population).	Fiscal decentralization in Spain is found to be negatively related to infant mortality over the period of study.
Ebel and Yilmaz (2001)	Six developing countries (Argentina, Brazil, Colombia, Philippines, South Africa and Venezuela)	1970-1999	GLS with fixed effects intervention analysis that evaluates the outcomes of decentralization in terms of immunization rates for DPT and measles of children under 12 months.	The results of the estimated model suggest that intervention by sub national governments has been associated with an increase in the coverage of children immunised for measles.
Habibi et al (2003)	A panel of 23 Argentinean	1970-1994	Fixed effect specification with infant mortality as the variable to be explained and two key decentralization	Decentralization has a negative and significant association with infant mortality rates. In addition, the study shows

	provinces		indicators: % of revenue raised locally and % of controlled revenue over the total. Other independent variables of the study are: provincial per capita GDP, total per capita expenditure of the province, and number of public employees per 1,000 provincial population.	that during the period of decentralization reforms studied, regional inequalities were considerably reduced.
Jiménez-Rubio (2010)	Ten provinces of Canada	1979-1995	Fixed effects model exploring the impact of a measure of decentralization of health spending (ratio of provincial health care expenditure over the total) on infant mortality. Other key determinants of infant mortality are: health spending by the federal government in absolute terms and the level of education.	The results of the empirical analysis suggest that decentralization in Canada appear to have had a positive and substantial influence on the effectiveness of public policy in improving population's health.
Khaleghian (2004)	140 low and middle income countries	1980-1997	Panel data examining the association between decentralization and immunisation coverage rates for DPT3 and measles of children at one year of age. Two indicators of fiscal decentralization were used: a.) binary variable defined as the presence of taxing, spending, or regulatory authority on the part of sub national authorities; b.) A combination of two variables: the share of sub national expenditures on total government expenditures, and the share of health spending on total sub national expenditures. The model used is a standard OLS multiple regression with Huber corrected standard errors. The control variables included are: GDP per capita, illiteracy rate, democracy score, ethnic tension, etc.	Decentralization improves immunization coverage rates only in low-income countries
Robalino et al (2001)	A panel data of low and high income countries 1970-1995	1970-1995	Fixed effects estimation techniques to test how a measure of fiscal decentralization -the proportion of sub national government spending over central government spending- affects infant mortality rates after controlling by a set of structural variables (GDP per capita, corruption, ethno-linguistic fractionalisation, etc.).	Decentralization is associated with lower infant mortality rates. Interestingly, the marginal benefit from decentralization is found to be greater at low-income levels.
Uchimura and Jütting (2009)	26 Chinese provinces	1995-2001	Fixed effects regression with nationwide county-level fiscal data as a proxy for decentralization: a measure of vertical balance, and the ratio of counties' aggregate expenditure to total provincial expenditure. Other explicative variables include: the provincial per capita GDP, the rural/urban ratio in the province, the provincial fertility rate, and the illiteracy rate.	The study finds that more decentralized provinces have lower infant mortality rates than more centralized ones. The authors conclude that in order for decentralization to achieve the desired effect it is important that counties receive intergovernmental transfers but it is also important that they have their own fiscal autonomy.

Source: Authors' own elaboration.

Table 2: Advantages and disadvantages of main fiscal decentralization indicators

Variable	Source	Advantages	Disadvantages
Proportion of sub national spending over the total	IMF	Long time series and cross sectional information	Overestimation of real level of local autonomy if local expenditures are tightly controlled by the centre
Proportion of sub national own revenues over the total	IMF	Long time series and cross sectional information	Overestimation of real level of local autonomy if tax revenues controlled by the centre are classified as sub national own-source revenue
Proportion of sub national own revenues over the total	OECD (1999)	Tax revenues can be classified according to the tax autonomy attributed to local governments, reflecting the true level of autonomy of local policy making	Small coverage: cross sectional information (1995) for 19 countries
Proportion of local government taxes where the local government controls the tax rate, the tax base, or both over the general government	Stegarescu (2005)	-Tax revenues can be classified according to the tax autonomy attributed to local governments, reflecting the true level of autonomy of local policy making -Large cross-sectional dataset: data for 23 countries over the period 1965-2001	Non-periodical data, highly costly to update

Source: Authors' own elaboration.

Table 3. Evolution of fiscal decentralization by country[a]

	AutTaxRevDec[b]		*ExpDec*[c]	
	1965-1973	**1999-2001**	**1970-1978**	**1996-2001**
1. Austria	19,7	17,2	48,6	51,7
2. Australia	2,9	3,0	32,7	32,3
3. Belgium	6,6	24,6	14,2	28,1
4. Canada	52,1	51,7	54,5	61,3
5. Denmark	27,3	32,6	57,2	56,5
6. France	1,9	18,0	17,3	18,32
7. Germany	7,5	6,9	44,0	35,0
8. Ireland	13,8	2,3	27,7	25,14
9. Italy	6,4	14,1	17,0	26,6
10. Japan	28,3	37,9	47,7	35,75
11. Netherlands	2,2	5,0	33,5	27,22
12. New Zealand	9,1	5,5	38,5	10,7
13. Norway	30,4	20,2	36,5	33,8
14. Portugal	0,0	3,2	6,4	10,3
15. Spain	4,8	22,1	10,1	36,61
16. Sweden	30,8	44,7	42,8	37,9
17. Switzerland	54,3	51,5	57,2	49,8
18. United Kingdom	13,8	5,1	30,7	22,1
19. United States	34,4	35,9	45,0	49,4

a) Iceland, Finland, Greece and Luxembourg were dropped from Stegarescu's dataset for the analysis due to insufficient observations on control variables.
b) Earliest data is between 1965 and 1975 and latest data is between 1999 and 2001
c) Earliest data is between 1970 and 1978 and latest data is between 1982 and 2001

Table 4. Descriptive statistics

Variable		Mean	Std. Dev.	Min	Max	Definition	Source
Infmort	overall	11,8	8,1	2,4	64,9	Infant mortality rate per 1000 live births	A
	between		4,0	7,4	26,0		
	within		7,0	-9,1	50,8		
AutTaxRevDec	overall	19,2	16,7	0,0	61,5	Sub-national own tax revenue over general government total revenue. Taxes included in the numerator include only those where the sub-national government can change the tax rate, the tax base or both	B
	between		16,2	0,3	56,5		
	within		3,3	7,7	32,4		
ExpDec	overall	33,0	14,9	3,2	62,6	Sub-national government expenditure over total government expenditure	C
	between		15,5	4,0	59,4		
	within		3,7	20,6	49,7		
Income	overall	20363,5	6192,9	6814,6	54285,3	GDP per capita in 2000 US dollars	A
	between		4447,1	11457,1	32489,8		
	within		4433,9	8019,5	42159,1		
Doctors	overall	2,1	0,8	0,8	4,4	Practising physicians density per 1000 population	A
	between		0,6	1,3	4,0		
	within		0,6	0,7	3,7		
Alcohol	overall	10,7	3,7	3,1	20,8	Alcohol consumption, litres per capita	A
	between		3,4	4,5	17,5		
	within		1,6	5,8	15,6		
Tobacco	overall	33,6	8,7	18,7	61,0	Percentage of population who are daily smokers	A
	between		6,4	19,7	45,2		
	within		5,6	17,9	53,5		
Education	overall	8,3	2,0	2,4	12,1	Average years of schooling of population aged 15 years and over	D
	between		1,8	3,8	11,0		
	within		1,0	5,5	11,2		

Sources of data: A.- OECD.Stat Extracts; B.- Dan Stegarescu's dataset (2005); C.-International Monetary Fund Government Finance Statistics (World Bank, 2010); D.- The CEP-OECD Institutions dataset 1960-2004 (Nickell, 2006)

Table 5. Estimation results: Panel Corrected Standard Errors[a,b]

	Infant mortality (ln)				
Regressors (ln)	**Coef.**	**z**	**Regressors (ln)**	**Coef.**	**z**
AutTaxRevDec	-0,05***	-3,1	***ExpDec***	-0,18***	-3,3
Income	-0,22*	-1,7	**Income**	-0,16	-1,2
Doctors	-0,17*	-1,8	**Doctors**	-0,18**	-2,1
Alcohol	0,08	1,1	**Alcohol**	0,04	0,6
Tobacco	-0,04	-0,9	**Tobacco**	-0,04	-1,1
Education	-0,21**	-2,0	**Education**	-0,27**	-2,5

*** - significant at 1%; ** - significant at 5%; * - significant at 10%
a- The estimations include country and year dummies
b- t statistics computed with panel corrected standard errors robust to heteroskedasticity and autocorrelation

Table 6. Estimation results: OLS with Newey-West standard errors

	Infant mortality (ln)				
Regressors (ln)	**Coef.**	**z**	**Regressors (ln)**	**Coef.**	**z**
AutTaxRevDec	-0,05**	-2,2	***ExpDec***	-0,29***	-4,7
Income	-0,40**	-2,4	**Income**	-0,25	-1,4
Doctors	-0,20*	-1,7	**Doctors**	-0,17	-1,6
Alcohol	0,11	1,2	**Alcohol**	0,01	0,1
Tobacco	-0,07	-0,9	**Tobacco**	0,01	0,1
Education	-0,29**	-2,0	**Education**	-0,33**	-2,5

*** - significant at 1%; ** - significant at 5%; * - significant at 10%
a- The estimations include country and year dummies
b- t statistics computed with Newey-West standard errors robust to heteroskedasticity and autocorrelation

Table 7. Estimation results: Feasible Generalized Least Squares[a,b]

	Infant mortality (ln)				
Regressors (ln)	**Coef.**	**z**	**Regressors (ln)**	**Coef.**	**z**
AutTaxRevDec	-0,02*	-1,7	***ExpDec***	-0,13***	-2,7
Income	-0,20*	-1,7	**Income**	-0,15	-1,3
Doctors	-0,09	-1,1	**Doctors**	-0,07	-1,0
Alcohol	0,07	1,2	**Alcohol**	0,05	0,7
Tobacco	-0,01	-0,2	**Tobacco**	-0,01	-0,3
Education	-0,22**	-2,2	**Education**	-0,25***	-2,7

*** - significant at 1%; ** - significant at 5%; * - significant at 10%
a- The estimations include country and year dummies
b- t statistics computed with standard errors robust to heteroskedasticity and autocorrelation