



Munich Personal RePEc Archive

Influence of climate conditions on tax revenues

Mutascu, Mihai

West University of Timisoara

June 2012

Online at <https://mpra.ub.uni-muenchen.de/40324/>
MPRA Paper No. 40324, posted 30 Jul 2012 13:38 UTC

Influence of climate conditions on tax revenues

(draft version, not for publication)

Mihai Mutascu

LEO (Laboratoire d'Economie d'Orléans) UMR7322
Faculté de Droit d'Economie et de Gestion, University of Orléans
Rue de Blois - B.P. 6739, 45067, Orléans, France

and

Faculty of Economics and Business Administration
West University of Timisoara
16, H. Pestalozzi St.
300115, Timisoara, Romania

Tel: +40 256 592505, Fax: +40 256 592500

Email: mihai.mutascu@gmail.com

Abstract: The paper investigates the effects of climate conditions on collected tax revenues, based on a panel-model approach. The data-set includes 123 countries and covers the period 1996-2010. The main results show that the assumed function is linear, the climate conditions having a significant impact on collected tax revenues. Overall, the collected tax revenues tend to increase under cool, polar or boreal climate. The paper extends the literature in the field by focusing on the climate implications in economy and finds new evidences regarding the determinants of collected tax revenues.

Key words: Climate conditions, Tax revenues, Panel-model, Effects, Tax policy

JEL-codes: Q54, H20, C23

1. Introduction

The modern government collects taxes and allocates them in order to fulfil his main constitutional goals, under an extended set of determinants, the climate being ignored a long period of time. Classical determinants of taxation are ordered by Lago-Peñas and Lago-Peñas (2008) in four categories: socio-demographic characteristics (gender, age, marital status, education, employment status, religiosity and social class); political and social attitudes (trust in courts, the legal system, trust in politicians, democracy level, national pride, social capital, the perception of corruption and voting behaviour); fiscal parameters (tax rates, fine rate, audit probability, risk

aversion and personal income); and contextual determinants (extent of direct democracy, language fragmentation and existence of regional cleavages).

It's easy to see that the mentioned categories don't take any geographical feature types into account. As Nordhaus (2006) shows, if the connections between economic phenomena or processes and geography is generally evident for quasi all persons, the modern macroeconomics ignore this linkage. Determinants such as climate conditions, water proxy, soils, pests and permafrost are practically ignored. According to the same author, there are two kinds of geophysical factors which can be used in economics studies: nonstochastic factors on the relevant time scale (latitude, distance from coastlines or elevation) and stochastic factors with slowly moving means and variability (climate conditions or soils).

What happen with collected tax revenues under stochastic geophysical factors? Does climate influence the collected tax revenues? If yes, which is the magnitude of this impact? These aspects are very important because the climate could accelerate or decelerate the government tax revenue inputs.

Regarding tax revenues under influence of climate conditions, the literature in the field is practically absent. Some results are obtained, but the analyses are focused on the climate impact on economic growth, economic development, revenues inequality, poverty, institutional quality or agricultural and industrial output. The pioneers in this topic are illustrious Montesquieu (1750) and Smith (1776), followed in contemporaneous period by Sachs and Warner (1997); Bloom and Sachs (1998); Gallup and Sachs (1999); Mellinger, Sachs and Gallup (1999); Hall and Jones (1999); Gallup, Sachs, and Mellinger (1999); Acemoglu, Johnson and Robinson (2002); Rodrik, Subramanian and Trebbi (2004); Sylwester (2004); Dell, Jones and Olken (2011) or Bansal and Ochoa (2012).

In the contemporaneous period, Sachs and Warner (1997) investigate the growth in 23 African countries, for the period 1965-1990, based on a cross-country regression model. The results show that the poor economic policies determine a slow economic growth, without any openness to international markets. Further, the authors add new determinants of slow growth: the lack of access to the sea and tropical climate conditions. One year later, Bloom and Sachs (1998) explore the influence of climatic conditions on some economic variables and emphasise that poorer zones are correlated with tropical climate, as results of tropical ecology effects on human health and agricultural productivity. The temperate climate is assimilated with the rich zones.

Dell, Jones and Olken (2011) change the type of climate with temperature in their investigations. The authors study the effect of temperature's fluctuations on economic activity, for a sample of 125 countries. The main conclusion shows that higher temperatures substantially reduce economic growth in poor countries. In parallel, they associate higher temperatures with reduced agricultural output, industrial output and political stability. More recently, Bansal and Ochoa (2012) investigate the connection between temperature, aggregate risk and expected returns, using a sample of 38 countries on the period 1960-2008. The researchers point out that temperature represents an aggregate risk factor of economic growth. In this respect, countries closer to the Equator reveal a positive temperature risk premium which decreases as one move farther away from the Equator.

New evidences concerning "climate - economy" nexus reveal Gallup and Sachs (1999). They focus on the food production and find a strong correlation between food production and climate zone type. Through some inputs, such as capital, labour and fertilizers, the food production is very low in tropical zone, compared with temperate zone which registers high food production.

Mellinger, Sachs and Gallup (1999) are more analytic, examining the connection between climate (ecozones), water navigability and economic development (GDP per capita) in the case of 152 countries, with a population of 1 million or more, in 1995. They emphasise that GDP per capita and density of economic activity (in GDP per km²) are high in temperate zone and in area proximate to the sea (within 100 km of the ocean or a sea-navigable waterway).

Hall and Jones (1999) choose a new topic: the impact of climate on revenues inequality. The authors focus on the issues of per capita incomes discrepancy across nations and illustrate a strong correlation between geography (measured as distance from the equator) and per capita output by country. The location affects economic success because the position of human settlements can influence institutions. On the same topic, Gallup, Sachs and Mellinger (1999) analyse the effects of location and climate on income levels and income growth. As a novelty, a set of control variables is used, such as: transport costs, disease burdens, agricultural productivity, among other channels. The main conclusion stresses that geography also affects economic policy choices.

Other authors connect temperature, as independent variables, with some national characteristics, such as institutional quality (e.g., Acemoglu, Johnson and Robinson 2002; Rodrik, Subramanian and Trebbi 2004). Concretely, the results of Rodrik, Subramanian and Trebbi (2004) reveal that the institutions, geography and trade are the most important determinants of income levels around the world. More, geography is considered to have weak direct effects on income levels. Sylwester (2004) juxtaposes the history with geography as important stimulants pair of institutions and income. Using a cross-section of countries approach, he point out that only being landlocked has a strong influence on revenues inequality.

Based on literature review, the aim of this paper is to analyse the effects of climate conditions on collected tax revenues, based on a panel-model approach. The data-set includes 123 countries and covers the period 1996-2010. We choose this extended world approach in order to capture all possible types of climate which should influence the tax revenues. As there is not any contribution in “climate-taxation” area, intuitively, at least two transmission channel could be identify: (i) first one, the direct impact of climate on tax revenues through taxpayers behaviour, and (ii) second one, the indirect influence of climate on tax revenues through some socio-economic variables or other indirect control determinants.

The present paper extends the literature in the field by focusing on the climate implications in economy and finds new evidences regarding the determinants of collected tax revenues. The main results show that the assumed function is linear, the climate conditions heaving a significant impact on collected tax revenues. As a consequence, in this case, tax policy implications have major amplitude and complexity levels.

The rest of the paper is structured as follows: Section 2 highlights the methodology and data. Section 3 contains the results. Section 4 concludes.

2. Methodology and data

The climate's tax implications are explored based on a large sample, determined by 123 cross-sections (123 countries), from 1996 to 2010 (Table 1, in Appendix), using a panel-model approach. Even if the period seems to be relatively short, one of the advantages of panel models, according to Kennedy (2003), is that “they can be used to analyze dynamics with only a short

time series”. More, the panel-models have the quality to capture the complexity of human behaviour than a single cross-section or time series data, as Hsiao (2007) notes.

Two variables are selected in order to investigate the impact of climate conditions on collected tax revenues: tax revenues, as dependent variable, and a climate type variable, as independent interest variable. The dependent variable is represented by tax revenues (τ) and reveals the level of tax revenues collected by general government in U.S. dollars. The data is taken from the International Monetary Fund online data-base.

The interest independent variable is climate type (δ) and represents a dummy variable. It is 1 if the climate is warm or tropical and 0 if the climate is cool, polar or boreal. The binary values of dummy variable are fixed according to IPCC’s (2006)¹ climate zone types (Figure 1, in Appendix). The climate zones are characterised by four coordinates: annual mean daily temperature, total annual precipitation, total annual potential evapo-transpiration (PET), and elevation. Nordhaus (2006) argues that for this type of approach some geographic variables could be clearly endogenous (e.g., coastal density, proximity to markets, and health status). To avoid this endogeneity issue, we choose dummy type for interest variable, which capture quasi all climate zone characteristics.

The principal hypothesis of this analysis is that the climate conditions determine the level of collected tax revenues, based on a function with this shape:

$$\tau = f(\delta), \quad (1)$$

where τ - the amount of tax revenues in U.S. dollars, and δ - the climate type dummy variable.

The basic OLS naïv panel-model 1, with natural logarithmic of variable τ , is as follows:

$$\ln(\tau_{it}) = \alpha + \beta_0 \delta_{it} + \varepsilon_{it}, \quad (2)$$

where α - intercept, β_0 - slope of interest variable, i - country, t - time and remainder, and ε_{it} - the error term, which varies over both country, and time.

We entered three categories of control variables: one inspired by appropriate tax literature, one derived from macroeconomic policy, and another one represented by robustness variables.

Based on this correction, the extended linear model becomes:

$$\ln(\tau_{it}) = \alpha + \beta_0 \delta_{it} + \sum_{k=1}^n \beta_k X_{k,it} + \mu_i + \lambda_t + \varepsilon_{it}, \quad (3)$$

where α - intercept, β_0 - coefficient of interest independent variable, β_k - coefficient of control independent variable k by n type, X - control independent variables, μ_i - stands for country fixed effects, λ_t - time-specific effect that controls for unaccounted common time-varying factors, i - country, t - time, and ε_{it} - the error term.

¹ IPCC (2006) is the acronym for International Panel on Climate Change. According to www.ipcc.ch, IPCC was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts.

The first group of control variables includes determinants from appropriate tax literature, such as: gross domestic product per capita (GDP per capita), size of industrial sector and size of agricultural sector. GDP per capita reveals the level of GDP in US dollars divided by midyear population and has a strong impact on tax revenues (e.g. Tosun and Abizadeh, 2005; Katircioglu, 2010). The last two variables, size of industrial sector and size of agricultural sector, measure the value added by industrial/agricultural sector as percent in GDP. There are a lot of studies which explain their significant effects on collected tax revenues (e.g. Agbeyegbe et al., 2006).

The second group of control determinants captures macroeconomic policy variables and includes: inflation rate, balance of trade, government debt, government final consumption expenditures and net foreign direct investments (FDI). The inflation rate is the percentage rate of change in consumer price level. Excellent contributions regarding the inflation - tax nexus are provided by Olivera (1967) and Tanzi (1977). Balance of trade measures the difference between monetary value of exports and imports of output in an economy, as percent of GDP. The balance of trade's importance on tax revenues is illustrated by Rodrik (1998) and Gupta (2007). The third control variable is government debt, which shows the general government gross debt as percent of GDP. Battaglini and Coate (2008) reveal some evidences regarding the relationship between public debt and tax revenues. The fourth variable, government final consumption expenditures, quantifies the government final consumption expenditure as percentage of GDP and also has a strong impact on tax revenues, as Taha and Loganathan (2008) note. The last control determinant by macroeconomic policy origins is the net FDI. It captures the difference between inward foreign direct investment and outward foreign direct investment as percent of GDP. Notable researches regarding the implications of net FDI on tax revenues are performed by Mintz (1994), Richter and Wellisch (1996), Huizinga and Nielsen (1997, 2002), Wildasin and Wilson (1998), Wildasin (2003), or Huizinga and Nicodème (2006).

The last group of control variables is for robustness and contains: government effectiveness, freedom from corruption, literacy index and democratization level. The government effectiveness captures the perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies (-2.5 shows a weak governance performance, while 2.5 a strong governance performance one). The impact of government effectiveness on collected tax revenues is very strong (e.g. Hanousek and Palda, 2004; and Lisi, 2011). Freedom from corruption reveals the corruption intensity (the score 100 means low corruption, while a level of 0 indicates a very corrupt government). Corruption - tax revenues nexus is favourite topic for Ghura (1998); Friedman, Johnson, Kaufmann and Zoido-Lobaton (2000); Fjeldstad and Tungodden (2001); or Imam and Jacobs (2007). Literacy index is the third control variable for robustness and indicates how many adults can read and write in a certain area or nation, as percent in total adult population. According to Kenney and Winer (2001) and Mahadavi (2008), this determinant is significant correlated with collected tax revenues. Finally, democratization level is captured by Polity2 index, with values from +10 (strongly democratic regime) to -10 (strongly autocratic regime). New investigations regarding the relationship between democratization level and tax revenues belong to Mutascu (2011).

Table 2 in Appendix shows several descriptive statistics of used variables, while Table 3 presents the source of data. All variables with strict positive values are treated as elasticity, except the inflation rate, balance of trade, government debt, net FDI, government effectiveness, and polity2.

The panel-data model may have heterogeneity in the data. As the investigated sample is unbalanced, we analyze this propriety only in the cases of fixed-effects models (the random effects panel-models are not consistent under unbalanced data-set). The hypothesis is tested using F-test, which permits to choose between pooled model and fixed-effects model. In this case, we consider all type of fixed-effects models: cross-section fixed-effects, period fixed-effects and both kind of effects. In the following section we present the empirical results of considered function, following several econometric scenarios (models 1-7), as Table 4, in Appendix, illustrates.

3. Results

The most important output shows that the interest variable “clime type” is significant and negative correlated with dependent variable - collected tax revenues - in all scenarios. In the panel OLS estimations, the control variables are significant, except the size of agricultural sector, inflation rate, literacy index and polity2. GDP per capita, size of industrial sector, balance of trade, government debt, government final consumption expenditures and government effectiveness are positive correlated with dependent variable, while the rest of significant explanatory variables have negative impact on tax revenues.

Further, we initiate the hypothesis tests to choose between pooled model and fixed-effects model. The values of F-test and Chi-square for fixed-effects denote that the OLS estimations are preferred to the period fixed-effects model. Regarding the cross-section and both cross-section and period fixed-effects models, the results of F-test and Chi-square indicate that the null hypothesis of no heterogeneity is not rejected. In this case, the cross-section and both cross-section and period fixed models are more appropriate than OLS panel models. For these kinds of models, the interest variable is also significant and negative correlated with tax revenues variable. The control variables GDP per capita, size of industrial sector, balance of trade and government effectiveness are significant and positive correlated with dependent variable (as exception, GDP per capita has negative sign for cross-section, and both cross-section and period fixed-effects model types). Otherwise, net FDI, freedom of corruption, literacy index and level of democratization have negative impact on tax revenues (the last two control variables are insignificant for the period fixed-effects model). These results confirm the main literature outputs regarding the sign of determinants for tax revenues, except the case of literacy index and polity2 variables.

The empirical findings, in the case of 123 investigated countries, for the period 1996-2010, reveal that all considered control determinants have significant impact on collected tax revenues (except especially size of agricultural sector, inflation rate, government debt and government final consumption expenditures), but the main result shows that the interest variable is significant and negative correlated with dependent variable. In respect to clime dummy variable, the collected tax revenues tend to increase under cool, polar or boreal climate.

4. Conclusions

Tax revenues represent the main financial government resources. These revenues have several determinants by economic, socio-demographic and politic type. As the economic literature doesn't take account by geographical conditions concerning tax revenues, our exploration demonstrates this new evidence, using climate zone conditions as main geographical determinant.

The connection "tax revenues-climate" could have two principal transmission channels: one direct, and other indirect. The direct channel implies that the level of collected tax revenues depends by citizens' behaviour, which differs from one climate zone to other. The indirect channel consists in impulse of climate conditions on tax revenues through a set of socio-economic determinants. In this case, even if the level of tax compliance is high, the amount of tax revenues is low as a consequence of weak economic power under climate conditions.

The results reveal that only cool, polar or boreal climate can ensure a strong volume of collected tax revenues. There are two reasons in this way. On the one hand, in this type of climate the level of tax compliance is higher than the tax compliance registered by the temperate and tropical climate zone. The behaviour of taxpayers in this cool climate zone is characterised by honesty, pragmatism, and also great independence of character, individual initiative, and tenacity of will, as McDougall (2005) notes. On the other hand, the output confirms the contributions of Sachs and Warner (1997), and Bloom and Sachs (1998) regarding the connection "growth-climate". According to the authors, these two variables are generally low in the countries situated in warm climate zone. As a consequence, this means that cool, polar or boreal climate accelerates the tax revenues collection through the high level of economic growth.

In the context of tax-policy implications, the study suggests that a significant increase of collected tax revenues, without a major negative reaction of taxpayers, can be easily obtained by public authority situated in cool, polar or boreal climate zone. Overall, these climate zones represent "the best environment for tax revenues", accelerating the tax revenues collection. This study could be easily extended over tax burden - climate nexus, as result of particular state behaviour under different types of climate.

References

Agbeyegbe, T., Stotsky, J., WoldeMariam A. (2006). Trade liberalization, exchange rate changes, and tax revenue in Sub-Saharan Africa. *Journal of Asian Economics*, 17: 261-284.

Acemoglu, D., Johnson, S., Robinson, J. (2002), Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution, *Quarterly Journal of Economics*, 117: 1231-1294.

Aidt, T.S., Jensen, P.S. (2009). Tax structure, size of government, and the extension of the voting franchise in Western Europe, 1860-1938, *International Tax and Public Finance*, 16: 362-394.

Aizenmana, J., & Jinjarak, Y. (2008). The Collection Efficiency of The Value Added Tax: Theory and International Evidence. *The Journal of International Trade & Economic Development*, 17(3): 391-410.

- Azzimonti, M. (2010). Barriers to Investment in Polarized Societies. MPRA Paper No. 25936, Online at <http://mpa.ub.uni-muenchen.de/25936>.
- Bansal, R., Ochoa, M. (2012), Temperature, Aggregate Risk, and Expected Returns, Duke University's Fuqua School of Business Working paper.
- Battaglini, M., Coate, S. (2008). A Dynamic Theory of Public Spending, Taxation, and Debt. *American Economic Review*. 98: 201–236.
- Bloom, D., Sachs, J. (1998), Geography, Demography, and Economic Growth in Africa, Center for International Development, Cambridge, Mass. Mimeo.
- Bohn, F. (2002). Public Finance under Political Instability and Debt Conditionality. Economics Discussion Papers from University of Essex, Department of Economics, No. 540.
- Cukierman, A., Edwards, S., Tabellini, G. (1992). Seigniorage and Political Instability. *The American Economic Review*, 82(3): 537-555.
- Dell, M., Jones, B., Olken, B. (2011). Temperature Shocks and Economic Growth: Evidence from the Last Half Century, MIT Working paper No. 3552.
- Fjeldstad, O-H., Tungodden, B. (2001). Fiscal Corruption: A vice or a virtue?, CMI Working Paper, 13.
- Friedman, E., Johnson, S., Kaufmann, D., Zoido-Lobaton, P. (2000). Dodging the Grabbing Hand: The Determinants of Unofficial Activity in 69 Countries, *Journal of Public Economics*, 76: 459-493.
- Gallup, J., Sachs, J., Mellinger, A. (1999), Geography and Economic Development, *International Regional Science Review*, 22(2): 179–232.
- Gallup, J., Sachs, J. (1999), Agricultural Productivity and Geography, Center for International Development, Cambridge, Mass. Mimeo.
- Ghura, D. (1998). Tax Revenue in Sub-Saharan Africa: Effects of Economic Policies and Corruption, IMF Working paper WP/98/135.
- Gupta, A. (2007). Determinants of Tax Revenue Efforts in Developing Countries, IMF Working Paper, No. WP/07/184.
- Hanousek, J. Palda, H. (2004), Quality of Government Services and the Civic Duty to Pay Taxes in the Czech and Slovak Republics, and other Transition Countries, *Kyklos*, 57(2): 237-252.

- Hsiao, C. (2007). Panel data analysis - advantages and challenges. *Sociedad Estadística Investigacion Operativa*, Test, 16(1), pp. 1-22. Retrieved from <http://www.springerlink.com/index/10.1007/s11749-007-0046-x>.
- Huizinga, H., Nicodème, G. (2006). Foreign ownership and corporate income taxation: An empirical evaluation, *European Economic Review*, 50: 1223-1244.
- Huizinga, H., Nielsen, S.B. (1997). Capital income and profit taxation with foreign ownership of firms. *Journal of International Economics*, 42: 149-165.
- Huizinga, H., Nielsen, S.B. (2002). The coordination of capital income and profit taxation with crossownership of firms. *Regional Science and Urban Economics*, 32: 1-26.
- Imam, P., Jacobs, D. (2007). Effect of Corruption on Tax Revenues in the Middle East, IMF Working paper, WP/07/270.
- Katircioglu, S. (2010). Is There a Long-Run Relationship Between Taxation and Growth: The Case of Turkey, *Romanian Journal of Economic Forecasting*. 1: 99-106.
- Kennedy, P. (2003). A guide to econometrics, Fifth Edition, MIT Press.
- Kenny, L. W., Winer, S.L. (2006). Tax Systems in the World: An Empirical Investigation into the Importance of Tax Bases, Administration Costs, Scale and Political Regime, *International Tax and Public Finance*, 13(2-3): 181-215.
- Lago-Peñas, I., Lago-Peñas, S. (2008). The Determinants of Tax Morale in Comparative Perspective: Evidence from a Multilevel Analysis, Instituto de Estudios Fiscales Working Paper No. 2/2008.
- Lisi, G. (2011). Job search theory and the slippery slope framework: an attempt to integration, Department of Economics, University of Cassino, Working Paper No.2.
- Mahdavi, S. (2008). The level and composition of tax revenue in developing countries: evidence from unbalanced panel data. *International Review of Economics and Finance*, 17: 607-617.
- McDougall, W. (2005). The Group Mind: A Sketch of the Principles of Collective Psychology with Some Attempt to Apply Them to the Interpretation of National Life and Character [Paperback], Kessinger Publishing, LLC.
- Melo, M. (2011). Institutional Weakness and the Puzzle of Argentina's Low Taxation. *Latin American Politics and Society*, 49(4): 115-148.
- Mintz, J.M. (1994). Is there a future for capital income taxation? *Canadian Tax Journal*, 42(6): 1469-1503.

Mellinger, A., Sachs, J., Gallup, J. (1999), Climate, Water Navigability, and Economic Development, Center for International Development at Harvard University, CID Working Paper No. 24.

Montesquieu, C. (1750). *The Spirit of Laws (Cambridge Texts in the History of Political Thought)*, Edited by Anne Cohler, Basia Carolyn Miller and Harold Samuel Stone, Cambridge University Press.

Mutascu, M. (2011). Taxation and Democracy, *Journal of Economic Policy Reform*, 14: 343-348.

Nordhaus, W. (2006). Geography and macroeconomics: New data and new findings, *PNAS*, 103(10), pp. 3510–3517.

Olivera, J. (1967). Money, prices and fiscal lags. A note on the dynamics of inflation. *Banca Nazionale del Lavoro Quaterly Review*, 20: 258-267.

Profeta., P., Scabrosetti, S. (2008). Political economy issues of taxation, in Bernardi, L., A. Barreix, A. Marenzi and P. Profeta (eds) *Tax Systems and Tax Reforms in Latin America*, London: Routledge.

Rieth, M. (2011). *Essays on Dynamic Macroeconomics: Debt, Taxation, and Policy Interaction*. Dissertation zur Erlangung des akademischen Grades, Doktor rerum politicarum der Technischen Universität Dortmund.

Richter, W.F., Wellisch, D. (1996). The provision of local public goods and factors in the presence of firm and household mobility. *Journal of Public Economics*, 60: 73-93.

Rodrik, D., Subramanian, A., Trebbi, F. (2004), Institutions Rule: The Primacy of Institutions Over Geography and Integration in Economic Development, *Journal of Economic Growth*, 9: 131-165.

Rodrik, D. (1998). Why do More Open Economies have Bigger Governments? *Journal of Political Economy*. 106: 997-1032.

Sachs and Warner (1997), Sources of Slow Growth in African Economies, *Journal of African Economies*, Vol.6(3), pp. 335-376.

Sylwester, K. (2004), A note on geography, institutions, and income inequality, *Economics Letters*, 85: 235-240.

Smith, A. (1776), *An Inquiry into the Nature and Causes of the Wealth of Nations*. 2 Vols. Edited by Edwin Canaan. Chicago Ill, University of Chicago Press.

Taha, R., Loganathan, N. (2008). Causality Between Tax Revenue and Government Spending in Malaysia. *The International Journal of Business and Finance Research*. 2(2): 63-73.

Tanzi, V. (1977). Inflation, lags in collection and the real value of the tax revenue. *IMF Staff Papers*, 24: 154-167.

Tosun, M. S. and S. Abizadeh (2005). Economic growth and tax components: An analysis of tax changes in OECD, *Applied Economics*, 37: 2251-2263.

Volkerink, B., De Haan, J. (1999). Political and institutional determinants of the tax mix: an empirical investigation for OECD countries. Research Report, from University of Groningen, Research Institute SOM (Systems, Organisations and Management), No. 99E05.

Whalley, J. (2002), Taxes and trade, The University of Western Ontario and NBER, Working paper, available at <http://siteresources.worldbank.org/INTTPA/Resources/WhalleyPaper.pdf>

Wildasin, D. (2003). Fiscal competition in space and time. *Journal of Public Economics*, 87: 2571-2588.

Wildasin, D., Wilson, J.D. (1998). Risky local bases: Risk-pooling vs. rent-capture. *Journal of Public Economics*, 69: 229-247.

*** (2012), The Heritage Foundation online data-base.

*** (2011), International Panel on Climate Change, www.ipcc.ch.

*** (2011), International Monetary Fund online data-base.

*** (2011), PolityTM IV Project Political Regime Characteristics and Transitions, 1800-2010 Dataset.

*** (2011). United Nations Development Programme online data-base.

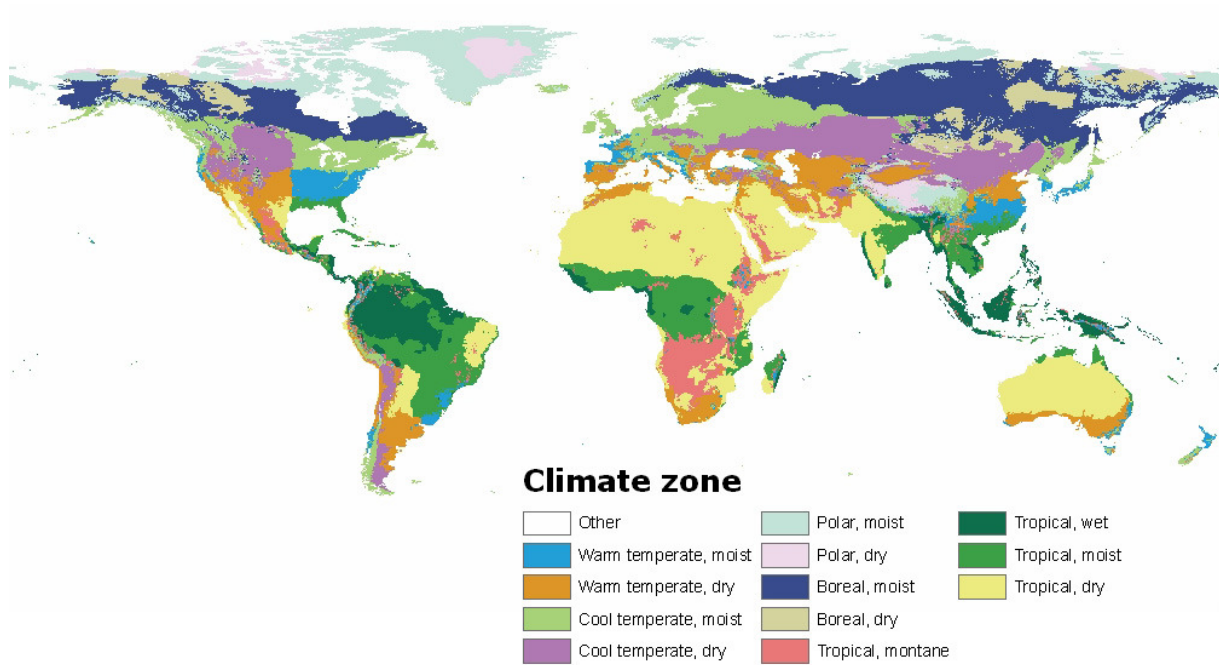
*** (2011), World Bank online data-base.

Appendix

Table 1: List of analyzed countries

Countries					
Albania	Central African Rep.	Germany	Lao People's Dem.Rep	Niger	Swaziland
Algeria	Chad	Ghana	Latvia	Nigeria	Sweden
Argentina	Chile	Greece	Lebanon	Norway	Switzerland
Armenia	China,P.R.: Mainland	Guatemala	Lesotho	Oman	Tajikistan
Australia	Colombia	Guyana	Libya	Pakistan	Togo
Austria	Costa Rica	Honduras	Lithuania	Panama	Trinidad and Tobago
Azerbaijan, Rep. of	Croatia	Hungary	Macedonia, FYR	Paraguay	Tunisia
Bahrain, Kingdom of	Cyprus	India	Madagascar	Peru	Turkey
Bangladesh	Czech Republic	Indonesia	Malawi	Philippines	Uganda
Belarus	Denmark	Iran, I.R. of	Malaysia	Poland	Ukraine
Belgium	Djibouti	Ireland	Mali	Portugal	United Arab Emirates
Benin	Dominican Republic	Israel	Mauritius	Qatar	United Kingdom
Bolivia	Ecuador	Italy	Mexico	Romania	United States
Botswana	Egypt	Jamaica	Moldova	Russian Federation	Uruguay
Brazil	El Salvador	Japan	Mongolia	Rwanda	Uzbekistan
Bulgaria	Estonia	Jordan	Morocco	Saudi Arabia	Venezuela, Rep. Bol.
Burkina Faso	Ethiopia	Kazakhstan	Mozambique	Senegal	Vietnam
Burundi	Fiji	Kenya	Nepal	Slovak Republic	Zambia
Cambodia	Finland	Korea, Republic of	Netherlands	Slovenia	
Cameroon	France	Kuwait	New Zealand	Spain	
Canada	Georgia	Kyrgyz Republic	Nicaragua	Sudan	

(for editor and referee only)



Source: International Panel on Climate Change (1996), www.ipcc.ch

Figure 1: Climate zone types

Table 2: Descriptive statistics

Variable	Mean	Median	Maximum	Minimum	Std. Dev.	Observations
Tax revenues (US dollars)	130183.3	12105.8	4784971	109.7	408090.6	1320
GDP per capita (US dollars)	9508.193	2937.433	93156.84	91.65949	13997.93	1320
Size of industrial sector as % of GDP	30.65618	29.03285	78.51812	10.68036	10.5007	1320
Size of agricultural sector as % of GDP	14.42649	9.416252	59.72044	0.355229	13.16061	1320
Inflation rate as % of GDP	6.103178	4.045315	85.74178	-9.863	6.887713	1320
Balance of trade as % of GDP	-4.519029	-2.59845	45.83854	-100.971	13.92318	1320
General government gross debt as % of GDP	52.62865	46.0935	235.596	0.55	33.66742	1320
Government final consumption expenditure as % of GDP	15.79292	15.74546	42.95028	2.675277	5.697811	1320
Net FDI as percent of GDP	2.500696	1.957294	46.50057	-22.7899	4.598441	1320
Government effectiveness	0.190568	-0.05	2.34	-1.62	0.958409	1320
Freedom of corruption	43.03561	35	100	10	23.05614	1320
Literacy index	0.867955	0.944432	1	0.083162	0.185077	1320
Polity2 index	5.016667	8	10	-10	6.046173	1320

Table 3: Source of data

Variable	Source
Tax revenues (US dollars)	International Monetary Fund online data-base (2011).
GDP per capita (US dollars)	United Nations Conference on Trade and Development (UNCTAD) online data-base (2011).
Size of industrial sector as % of GDP	World Bank online data-base (2011).
Size of agricultural sector as % of GDP	World Bank online data-base (2011).
Inflation rate as % of GDP	International Monetary Fund online data-base (2011).
Balance of trade as % of GDP	International Monetary Fund online data-base (2011).
General government gross debt as % of GDP	International Monetary Fund online data-base (2011).
Government final consumption expenditure as % of GDP	World Bank online data-base (2011).
Net FDI	United Nations Development Programme online data-base (2011).
Government effectiveness	World Bank online data-base (2011).
Freedom of corruption	The Heritage Foundation online data-base (2012).
Literacy index	United Nations Development Programme online data-base (2011).
Polity2 index	Polity™ IV Project Political Regime Characteristics and Transitions, 1800-2010 Dataset (2011).

Table 4: Empirical results of panel regressions

Dependent variable: In tax revenues (\$)							
Independent variables	Model						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
constant	10.647*** (0.038)	-1.119** (0.472)	0.7655 (1.072)	2.586*** (0.978)	2.892*** (0.473)	2.632*** (0.985)	2.806*** (0.446)
clime dummy	-1.877*** (0.038)	-0.068*** (0.024)	-0.1809*** (0.048)	-0.114** (0.046)	-0.476*** (0.145)	-0.114** (0.047)	-0.476*** (0.001)
In GDP per capita		1.005*** (0.04)	0.926*** (0.072)	0.84*** (0.079)	1.124*** (0.06)	0.839*** (0.08)	1.123*** (0.061)
In size of industrial as % of GDP		0.76*** (0.069)	0.259** (0.104)	0.531*** (0.095)	-0.281** (0.116)	0.539*** (0.096)	-0.247** (0.105)
In size of agricultural as % of GDP		-0.088 (0.06)	-0.021 (0.118)	-0.046 (0.107)	0.07 (0.086)	-0.049 (0.107)	0.072 (0.088)
inflation rate (%)			0.005 (0.004)	0.006 (0.005)	-0.005 (0.003)	0.006 (0.005)	-0.005 (0.003)
balance of trade as % of GDP			0.035*** (0.003)	0.027*** (0.003)	0.015*** (0.001)	0.027*** (0.003)	0.0007*** (0.001)
In general government gross debt as % of GDP			0.004*** (0.001)	0.004*** (0.001)	0.0006 (0.0008)	0.004 (0.001)	0.0007 (0.0008)
In government final consumption expenditure as % of GDP			0.108** (0.054)	0.104* (0.054)	0.048 (0.127)	0.099* (0.056)	0.053 (0.129)
net FDI as % in GDP				-0.043*** (0.006)	-0.028*** (0.007)	-0.044*** (0.006)	-0.029*** (0.007)

government effectiveness				0.458*** (0.054)	0.452*** (0.054)	0.463*** (0.054)	0.46*** (0.052)
ln freedom of corruption				-0.569*** (0.064)	-0.413*** (0.099)	-0.579*** (0.065)	-0.425*** (0.098)
ln literacy index				-0.149 (0.14)	-0.76*** (0.139)	-0.142 (0.14)	-0.142*** (0.141)
polity2 index				0.0006 (0.007)	-0.036*** (0.006)	0.0003 (0.007)	-0.037*** (0.006)
Type of estimation	PLS	PLS	PLS	PLS	PLS (FE:CS)	PLS (FE:PE)	PLS (FE and PE)
Model summary							
R-squared	0.126	0.608	0.641	0.651	0.878	0.652	0.878
F-test for fixed effects					20.1 (0.0000)	0.24 (0.9987)	17.72 (0.0000)
Chi-square					1429.1 (0.0000)	3.68 (0.9986)	1437.6 (0.0000)

(a) (...) denotes the standard error.

(b) PLS represents panel least squares.

(c) FE:CS and FE:PE denote cross-section fixed-effects, respectively period fixed-effects.

(d) ***, **, and * denote significance at 1, 5 and 10 % level of significance, respectively.