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Taxes, public spendings and economic growth in OECD countries

Abstract

Impacts of taxes and spending on accumulation and growth are assessed theoretically using neoclassical, optimal growth and overlapping generation models. Empirical supports based on rank correlation and panel regression analysis suggest that countries with higher tax GDP ratio generally had lower growth rates compared to those with lower ratio in OECD when examined the period from 1991 to 2006. The country and time specific factors seem to play more prominent role than the taxes. Country specific differences have their historical roots as collective preferences, constraints on sizes and modalities of public goods and services and willingness to pay for them, the optimal size of private sectors and the desire for economic freedom are influenced by those factors. Time specific factors owe to international business cycles. Real factors including the rate of capital formation, human capital and technology are more important for growth than the tax rates as higher tax rates are associated with higher rate of public services. Negative effects of taxes are often compensated by positive effects of public goods, thus, leaving a very small net negative impact on growth.

Keywords: taxes, spending, growth, OECD.
JEL Classification: D90, H20, H50, P35.

Introduction

Millions of working men and women in OECD countries pay local and national taxes on their labor, capital or other incomes and on consumption. They receive public goods and services including health, education, unemployment insurance, pension and social security or income subsidy from national and local public institutions. Ratios of revenue and public spending to GDP vary enormously across these countries due to the generousness of the social security system or the rates of economic growth.

Consider few relevant facts. The republic of Ireland grew impressively by 7.9 percent during 1994-2004 maintaining revenue and spending ratios just around 35 percent of GDP; South Korea had about 5 percent annual growth rate during that period with even smaller public sector of around 31 percent of its GDP. In contrast, Japan grew only by 1.2 percent, despite a large public sector deficit, which separated its revenue and spending ratios by a whopping 7 percent of its GDP (30.3 and 38.2 percent, respectively). Sweden had about the same rate of growth of 2.8 percent as in UK despite having about 17 percent higher revenue GDP ratio than that of UK. In contrast, growth rate of Denmark was just 2.1 percent with the relative size of the public sector even larger than that of Sweden. Sources of revenue and sectors of public spending vary in their nature and magnitudes among them. About 59 percent of public spending was classified as social spending for Germany but only 18 percent for Korea.

Why are the sizes of public sector and growth rates so different among these countries? How far do the variations in the sizes of public sector explain variation in their growth rates?

The first one is a political economic question that relates basically to the freedom of choice of individual citizens in these countries between private and public goods. From very ancient times states have been raising public funds to provide public goods. Tax rate was six percent of income even in ancient India as in Europe. Sizes of governments have increased as the responsibilities of states have risen out of proportions. Enough debates have taken place regarding the optimal size of the government (Pigou, 1947; Samuelson, 1954; Buchanan, 1965; Atkinson and Stern, 1974; Feldstein, 1974; Whalley, 1975; Boadway, 1979; Summer, 1980; Blomquest, 1985; Bovenberg, 1989; Benabou, 2002; Taveres, 2004; Fullerton and Heutel, 2007; Chen, 2007). In more modern times classical or new classical economists favored a smaller size of government that only focuses on providing pure public goods, such as national defence and internal law and order. The Keynesians or new Keynesians implicitly have argued for larger economic roles for public sectors to stabilize economy from vagaries of market fluctuations. There is extensive literature: Pareto optimality, Benthamian utilitarian analyses on social welfare, Arrows' impossibility theorem of equity and efficiency by means of voting mechanism or the Rawalsonian principle of social justice judged from the welfare of the lowest income person to Little-Mirrlees principles of social cost benefit analyses. These entrust public authorities as guarantor of efficiency in resource allocation and in bringing reasonable amount of equity of income among citizens by means of tax and transfer mechanism. They recommend proper use of public funds in providing kind benefits and other public goods. In its extreme version, in Marxist or communists thinking, state is

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at the forefront of economic management in which governments of proletariats take control over almost every economic decision. State owns most of the assets and reaps their profits, uses them in creating monolith infrastructure irrespective of demand of the consumers. In contrast, consumers are sovereign in the capitalist system where almost all productive activities are guided by invisible hands of market prices that provide enough signals to producers who supply various commodities that enter into consumption baskets of individuals. Only pure public goods are provided by the state. Despite this theoretical dichotomy, both private and public sectors remain active in reality for providing commodities and services in almost all countries. Therefore, a clear view on principles of optimal size of public sector, optimal taxation and public spending and factors is not only relevant for a major political parties contesting for power or running a government but also for economic and political thinkers who are active in theorizing on optimal size of the government with sufficient degree of individual freedom.

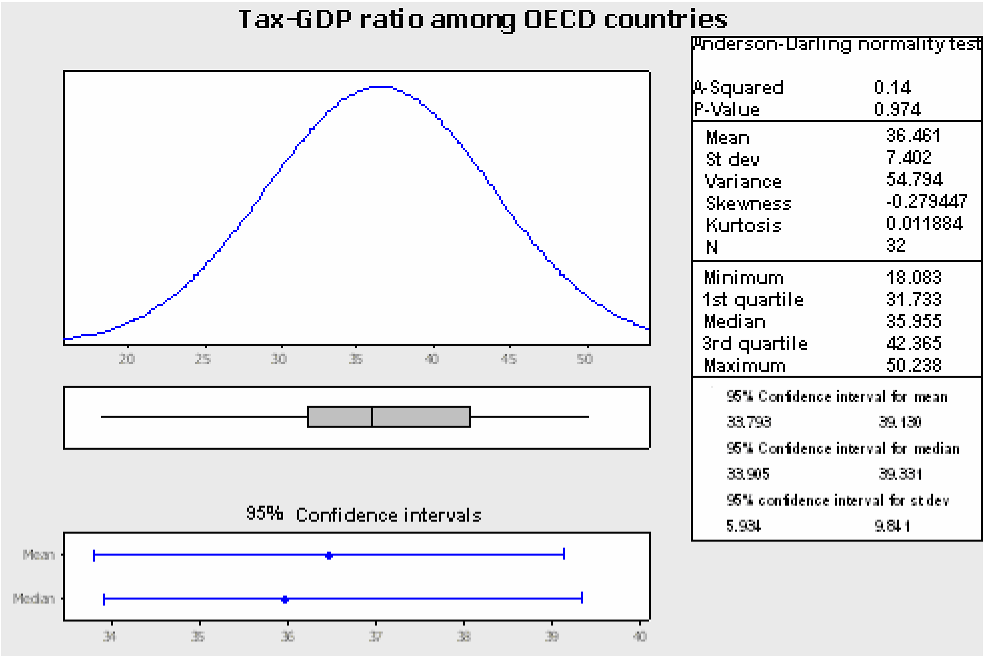


Fig. 1. Distribution of average tax rates among OECD countries, 1994-2005

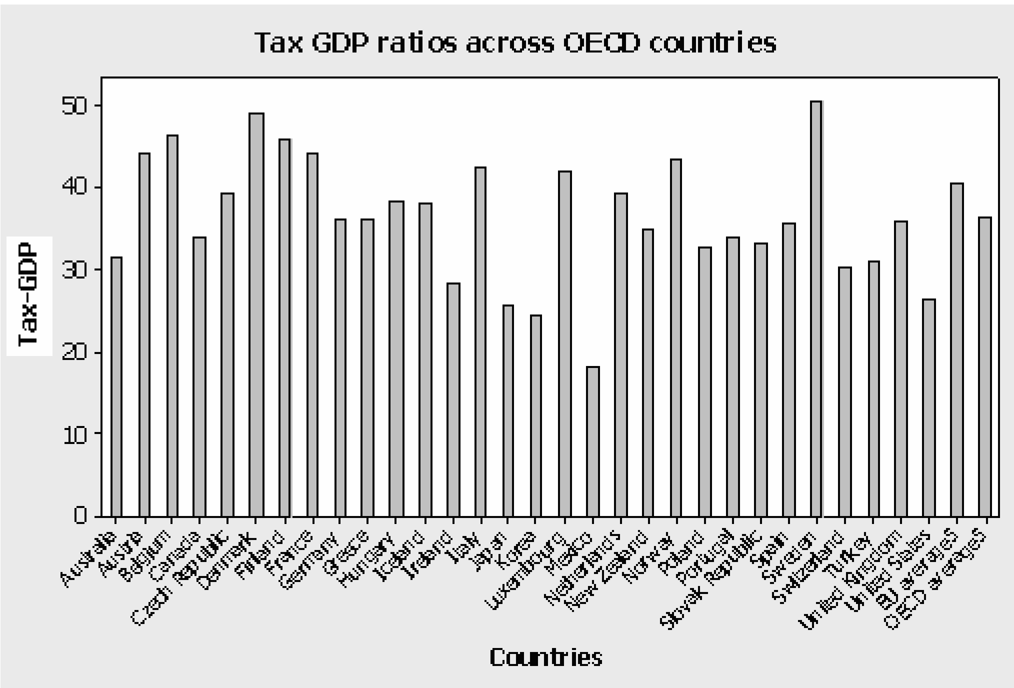


Fig. 2. Average tax rates among OECD countries, 1994-2005

The next question relates to the impact of public sector on economic growth. All kinds of taxes are distortionary on the one side and they create public goods and economic infrastructure on the other. Which one of these two effects is stronger is not clear at all. Is the larger size of public sector necessarily harmful for economic growth? Do the benefits generated by public goods compensate enough for the distortions? What levels of public services generate enough infrastructures and maintain good incentives required for a healthy economy? How can one make collections of taxes and allocations of spending more effectively? What are the criteria for efficient amounts of surplus, deficit or debt? Ideas of Harberger (1962), Uzawa (1962), Cass (1965), Atkinson (1971), Goulder and Summers (1989), King and Rebelo (1993), Perroni (1995), Cummins, Hasset and Hubbard (1996), Rust and Phelan (1997), Dhillon, Perroni and Scharf(1999), Wagstaff (1999), Caucutt, Imrohoroglu and Kumar (2006), Krueckner (2006), Di Tella and MacCullock (2006) have further illuminated on this debate.

The major aim of this paper is to explain why there are differences in the patterns and structure of revenue and spending in the OECD countries and to assess economic impact of these choices on economic growth. Such analysis can provide an evidence based assessment on the likely impacts of the reduction of average tax rate from 22 to 20 pence and corporate tax rates from 30 to 28 pence from April 2008 in UK and subsequent policies on spending and revenue sides to fight recession adopted in April 2009. Can these steps towards less distortion be expected to bring higher rates of economic growth? Impacts of taxes and spending on accumulation and growth are assessed theoretically using neoclassical, optimal growth and overlapping generation models with empirical support based on rank correlation analysis.

1. Economic factors determining the size of the public sector

Markets underprovide goods with positive externalities, such as education, health street lights or public gardens, and overproduce goods with negative externalities such as transportation by polluting vehicles and traffic congestions or outputs with higher amount of carbon footprints in industrial production. Optimal provision of public goods with positive and negative externalities and maintaining the social justice through redistribution are theoretical justification for the existence of the public sector. There seems to be a great difference in this optimal size of the public sector across countries because of historical reasons. Perceptions of individuals vary across countries regarding the degree of risk aversion and the extent of such market failure and hence, need for state intervention in economic activities and need for the government that aims to ensure equity, efficiency and stability, using various tax and spending strategies. For instance, the 2007 budget for the UK aimed to bring prosperity and fairness for families by maintaining a stable economy, promoting enterprises, innovations and skills, creating employment opportunities for all, providing high quality public services and protecting the environment. It aimed to strengthen an egalitarian society by maintaining a competitive economy.

How much of semi-public goods, such as education and health, should be provided by state really depends on preferences of individual and the budget constraint faced by each individual. Economists have used utility maximizing models to solve the question regarding the various size of public sector in an economy (Pigou, 1947; Samuelson, 1954; Atkinson and Stern, 1974 as illustrated in Figure 1; see texts, such as Boadway, 1984; Musgrave and Musgrave, 1980; Atkinson and Stiglitz, 1980; Myles, 1995; Muller, 1991; Shoven and Whalley, 1992; and Hillman, 2003).

Consider a problem of a representative household in an economy, as in a problem section of Atkinson and Stiglitz (1980), which gains utility from the consumption of public goods and the net of tax income. The problems can be formulated as:

$$\max \quad U^h = (1-\alpha)\ln\left(Y^h - T^h\right) + \alpha \ln G$$

subject to

$$P\left(Y^h - T^h\right) + G = I\ ,$$

where U^h is the utility of households, $\left(Y^h - T^h\right)$ is the net of tax income, G is the public good and α is the weight in utility from consumption of public goods. The production side of the economy is represented here by income for simplicity. When the desire for public goods is linearly related with the level of income the decision of a median voter determines the level of public good to be provided in an economy. When representative voter determines the size of the optimal public sector, then this problem can be applied to the economy as a whole. Market clears and total output is consumed either by the private or the public sector. Forming the constrained optimization problem, the Lagrangian function is given by

$$L\left(Y^h, G\right) = (1-\alpha)\ln\left(Y^h - T^h\right) + \alpha \ln G + \lambda\left[I - PY^h - G\right].$$

Then the first order conditions can be used to find the optimal amount of public spending in this economy.

$$\frac{\partial L\left(Y^h, G\right)}{\partial Y^h} = \frac{(1-\alpha)}{\left(Y^h - T^h\right)} - \lambda P = 0$$ and

$\frac{\partial L\left(Y^h, G\right)}{\partial G} = \frac{\alpha}{G} - \lambda = 0$, and using the marginal rate of substitution between the public and private goods $\frac{(1-\alpha)}{\left(Y^h - T^h\right)} \frac{G}{\alpha} = P$.

With a representative median voter facing a lump-sum tax of T, the total public good for the economy is $G = PT^h = PT$. Using this information in the first order condition the demand for public good by each individual is given by $\frac{G}{P} = \alpha Y$. It is possible to imagine a distribution of α across countries giving a distribution of the size of the state.

From this result we can say that it is optimal to have a large public sector if there are more preferences for public good among citizens of a country. Very high presence of public good seen in Scandinavian countries and Germany is indicative of preferences of households. Similarly, countries with lower α, such as Mexico or Korea, rely more on private sectors rather than on public sector for providing semi public goods. These results can be represented by a single peaked utility function, as shown in Figure 3.

Utility from public sector spending (disutility of taxes) is higher (lower) for lower levels of public spending. Net benefit, that is significant in the beginning declines gradually and reduces towards zero at point Go.

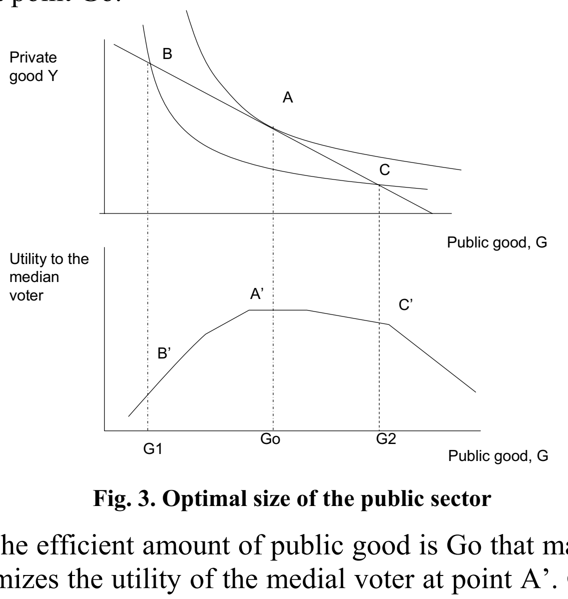


Fig. 3. Optimal size of the public sector

The efficient amount of public good is Go that maximizes the utility of the medial voter at point A'. G1 amount of public good is too little and G2 amount is too much. Preferences for public goods have their historic origin. Some economies like to have more public goods than others. Gradual process of social transformation in Europe after the Magna Carta (1215) and successive reforms before and after the Industrial Revolution have produced more liberal constitutions made by majority of workers in European economies. These countries are more inclined to more egalitarian distribution and greater size of public spending. US constitution in contrast was formulated by group of wealthy and business minded people, therefore, it has resulted in less provision by state. Health care is public good in most of the Europe but mostly a private good in the United States. There are similar parallels in the education sector. Thus, heterogeneity of preferences for public goods has led to variation in the amount of the public good provided across OECD economies. As Arrows impossibility theorem has shown, the majority voting rule does not generate a unique equilibrium with public goods. When people are free to choose there is a tendency for free riding.

In Lindhal equilibrium individuals pay according to the marginal benefit they receive from public services but enjoy the same amount of public good. Law of diminishing marginal utility applied to the amount of public good – a given amount of public good generates various amount of benefit to various people. Therefore, first best solution is to charge according to marginal values. For instance, consider an amount of public good equal to G. Then order utilities from (taxes paid for) public goods for each individual are as follows

$MU_1(G) = T_1 < MU_2(G) = T_2 < ... < MU_N(G) = T_N$. Then the total tax revenue is just enough to pay for public good $\sum_{i=1}^{N} T_i = P$. As it is difficult to obverse the marginal benefit of each individual, the second best solutions need to be designed in practice. Such equilibrium results from second best instruments, such as the lump sum taxes where the consumption of public good varies among people though they pay the same amount of taxes.

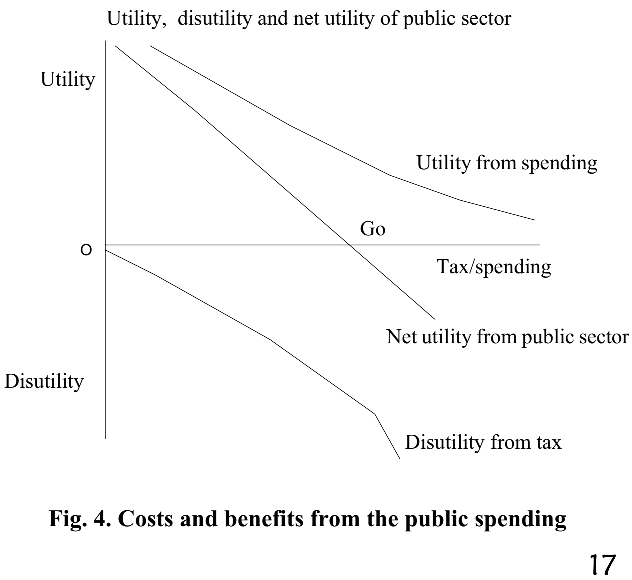


Fig. 4. Costs and benefits from the public spending

It is possible to show the Pareto optimality condition for optimal allocation of private and public goods among two individuals using a popular model by Samuelson, which states that sum of the marginal rate of substitution between private and public goods by two individuals should equal the marginal cost of provision of public goods in equilibrium using the utility possibility frontier approach as

$$Max \quad u_1 = u_1(x_1, G)$$

subject to 1) $\bar{u}_2 = u_2(x_2, G)$,

2) $x_1 + x_2 + c(G) = w_1 + w_2$.

Lagrangian of the problem:

$$L = u_1(x_1, G) - \lambda(u_2(x_2, G) - \bar{u}_2) - \mu(x_1 + x_2 + c(G) - w_1 - w_2).$$

Three first order conditions:

1. $\frac{\partial L}{\partial x_1} = \frac{\partial u_1(x_1, G)}{\partial x_1} - \mu = 0$ or $\mu = \frac{\partial u_1(x_1, G)}{\partial x_1}$;
2. $\frac{\partial L}{\partial x_2} = -\lambda \frac{\partial u_2(x_2, G)}{\partial x_2} - \mu = 0$ or $-\frac{\partial u_2(x_2, G)}{\partial x_2} = \frac{\mu}{\lambda}$;
3. $\frac{\partial L}{\partial G} = \frac{\partial u_1(x_1, G)}{\partial G} - \lambda \frac{\partial u_2(x_2, G)}{\partial G} - \mu \frac{\partial c(G)}{\partial G} = 0$ or

$$\frac{1}{\mu}\frac{\partial u_1(x_1, G)}{\partial G} - \frac{\lambda}{\mu}\frac{\partial u_2(x_2, G)}{\partial G} = \frac{\partial c(G)}{\partial G}$$

$$\frac{\frac{\partial u_1(x_1, G)}{\partial G}}{\frac{\partial u_1(x_1, G)}{\partial x_1}} + \frac{\frac{\partial u_2(x_2, G)}{\partial G}}{\frac{\partial u_2(x_1, G)}{\partial x_2}} = \frac{\partial c(G)}{\partial G} \text{ or}$$

$MRS_1 + MRS_2 = MC(G)$ Q.E.D.

Apparently, there seems to be a big difference on how people evaluate benefits and costs from the public sector. Countries that have many citizens with higher valuation of public services have larger public sectors, and countries with smaller number of citizens with higher valuation of public services have lower public sectors. This is clear from analysis of data. There is hardly any difference in pure government consumption to GDP ratio across OECD countries. There is a big disparity in social security payments. More egalitarian countries have more socialist distribution compared to more capitalist countries. Proportional or progressive tax systems in line with Mirrlees (1971) can be designed to approximate the first best solution that matches the preferences for public goods to tax payments and for efficient allocation of public resources.

2. Impact of taxes on economic growth

Do differences in the size of public revenue and spending explain differences in their growth rates? To what extent do choices of public revenue and spending policies matter for growth rates? This issue is analyzed below using three different models: 1) a neoclassical growth model with constant rate of saving functions for workers and capitalists as presented in Feldstein (1974); 2) Ramsey model with taxes in optimal growth framework, and; 3) a version of overlapping generation model as popularized by Auerbach and Kotlikoff (1987).

Starting point for the neoclassical growth model is a production function:

$$y = f(k).$$

Optimality requires that the gross factor price needs to equal the marginal product. In the presence of capital income tax the gross of tax returns on capital needs to equal the marginal productivity of capital as:

$$f' = r(1+t) \text{ [note: } dr = f''dk(1+t)^{-1} - f'(1+t)^{-2}dt \text{]}.$$

Remaining of the output is paid to the labor.

$$y - kf' = w.$$

Deeper thinking about how much share of income should go to capital and how much to labor brings us to the deep socio-political economic debate that has occurred on many phases of revolutions and reforms over at least a century. In most European countries working class was able to put forwards its demands for minimum wages, safety and security over the capitalists giving rise to socialist pattern of distribution with a significant proportion of income used as taxes and transfers, as seen in these economies. Capitalist ideas got more importance in terms of protecting private ownership and more competitive market economy in the US or Japan. Despite this, economists generally agree that more efficient allocation of resources requires payments to the factor of production according to their marginal productivities. This is the fundamental mechanism of allocation of scarce inputs in all OECD countries.

By market clearing assumption total of consumption, investment and government spending equal aggregate output. Income and expenditure balance needs to be maintained.

$$y = c + i + g = c + tkf' + s.$$

In the long run, revenue and spending of government sector are balanced, $g = tkf'$, and the steady equilibrium requires saving equal to investment. With n rate of population growth and no depreciation equal investment just nk.

$$s = nk.$$

The wage earners and profit (interest) earners save at different rates

$$s = S_L(w)w + S_K(r)rk$$

net investment equals available saving in the steady state.

$$nk = S_L(w)(f - kf') + S_K(r)kf'(1+t)^{-1} = S_L f - S_L kf' + S_K kf'(1+t)^{-1}.$$

Impact of tax on accumulation and growth can be studied by taking the total differentiation of this equation and by rearranging terms

$$n.dk = fS_L^{'}dr + S_L f' dk - S_L f' dk - S_L kf'' dk - kf' S_L^{'} dr + S_K f'(1+t)^{-1} dk$$
$$+ S_K k(1+t)^{-1} f'' dk - S_K kf'(1+t)^{-2} + kf'(1+t)^{-1} S_K^{'} dr.$$

Replacing the n term dr

$$n = S_L fk^{-1} - S_L f' + S_K f'(1+t)^{-1} \text{ and } dr = f'' dk(1+t)^{-1} - f'(1+t)^{-2} dt$$

$$.\left[S_L fk^{-1} - S_L f' + S_K f'(1+t)^{-1}\right]dk = fS_L^{'}\left[f'' dk(1+t)^{-1} - f'(1+t)^{-2} dt\right] + S_L f' dk$$
$$- S_L f' dk - S_L kf'' dk - kf' S_L^{'}\left[f'' dk(1+t)^{-1} - f'(1+t)^{-2} dt\right]$$
$$+ S_K f'(1+t)^{-1} dk + S_K k(1+t)^{-1} f'' dk - S_K kf'(1+t)^{-2} dt + kf'(1+t)^{-1} S_K^{'}\left[f'' dk(1+t)^{-1} - f'(1+t)^{-2} dt\right].$$

Collecting terms

$$.\frac{dk}{dt} = \frac{-\left(fS_L^{'} f'(1+t)^{-2} - kf'^2 S_L^{'}(1+t)^{-2} + S_K kf'(1+t)^{-2} + kf'^2 S_K^{'}(1+t)^{-3}\right)}{\begin{pmatrix} S_L fk^{-1} - S_L f' + S_K f'(1+t)^{-1} - fS_L^{'} f''(1+t)^{-1} + S_L kf'' - kf' S_L^{'} f''(1+t)^{-1} - S_K f'(1+t)^{-1} \\ - S_K kf''(1+t)^{-1} - kf'(1+t)^{-2} S_K^{'} f'' \end{pmatrix}}.$$

Thus, the impact of taxes on capital income in accumulation not only depends on the tax rate but also on the marginal productivity of capital and its rate of decline, propensities of saving from capital and labor incomes, their relations as shown above as output depends on per capita income $y = f(k)$ and capital stock accumulates in response to the investment $k_t = k_{t-1} + nk_t$ fundamentally at the rate of population growth rate. Many simplifying assumptions behind this model – particularly fixed saving rate from wage and capital income − are relaxed in Ramsey's optimal growth model.

2.1. Optimal Ramsey model for decentralized economy. An individual maximizes total life time utility by private (*C*) and public (*G*) good,

$$U_0 = \sum_{t=0}^{\infty} \rho^t \ln(C_t) + \sum_{t=0}^{\infty} \gamma^t \ln(G_t)$$

subject to boundary constraints on capital, K_o and K_T as well as an exogenous process of growth of labor $L_T = L_o e^{nt}$ and the technology A_t. Firms maximize profit subject to a constant returns to scale technology constraint, $Y_t = A_t K_t^{\beta} L_t^{(1-\beta)}$, $0 < \beta < 1$ law of motion of capital, $K_{t+1} = (1-\delta)K_t + I_t$, terminal condition $I_T = (g+\delta)K_T$, and marginal productivity principal of optimal rewards $r_t = \beta A_t K_t^{\beta-1}(1-\delta)(1-t_k)$; government balances its account by balancing spending to revenue from capital income tax, $G_t = \beta A_t K_t^{\beta-1}(1-\delta)t_k K_t$. The household optimization requires fulfilment of the Euler equation, $C_t(1+r_{t+1}) = C_{t+1}(1+\rho)$. Market should clear in aggregate, so that total supply equals total demand, $G_t = Y_t - C_t - I_t$. In steady state of this model $1 + r = 1 + \rho$ the interest equals the subjective discount factors. In this problem with exogenous process of technology, capital is the state variable and consumption is the control one. By substituting all the model elements the objective function can be rewritten as

$$U_0 = \sum_{t=0}^{\infty} \beta^t \ln\left(A_t K_t^{\beta} L_t^{(1-\beta)} - \beta A_t K_t^{\beta-1}(1-\delta)t_k K_t - K_{t+1} + (1-\delta)K_t\right) + \sum_{t=0}^{\infty} \gamma^t \ln\left(\beta A_t K_t^{\beta-1}(1-\delta)t_k K_t\right).$$

The transitional dynamics can be calculated by iterative solution of the Euler equation using the initial condition to find the path of the whole economy:

$$\left(A_t K_t^{\beta} L_t^{(1-\beta)} - \beta A_t K_t^{\beta-1}(1-\delta)t_k K_t - K_{t+1} + (1-\delta)K_t\right)(1 + r_{t+1}) =$$
$$\left(A_{t+1} K_{t+1}^{\beta} L_{t+1}^{(1-\beta)} - \beta A_{t+1} K_{t+1}^{\beta-1}(1-\delta)t_k K_{t+1} - K_{t+2} + (1-\delta)K_{t+1}\right)(1+\beta),$$

where $r_t = \beta A_t K_t^{\beta-1}(1-\delta)(1-t_k)$. The impact of taxes on output, capital, investment and consumption is very obvious. This model can be calibrated with the country specific parameters for each OECD economy.

2.2. Impact of taxes in an overlapping generation model. Economic behaviors of young and old generations differ significantly and have impacts on growth and equilibrium. Both neoclassical and Ramsey models did not distinguish generations. The transition dynamics in the neoclassical model is given by the law of motion of the capital stock. Consider an economy inhibited by *N* number of individuals. In period *0* each of them is endowed by k_0 capital stock and aggregate capital stock is K_0. The level of technical know how is denoted by *A*. Production technology is standard Cobb-Douglas production function: $Y_t = AK_t^{\beta} L_t^{(1-\beta)}$. This implies per capita output to be $y_t = A_t k_t^{\beta}$. Let the labor force L_t be fixed to *N* in each period. The remuneration to capital is according to its marginal productivity; $r_t = \frac{\partial y_t}{\partial k_t} = \beta A_t k_t^{\beta-1}(1-t_k)$. Labor is paid the residual amount: $w_t = \frac{\partial y_t}{\partial L_t} = (1-\beta)A_t k_t^{\beta}(1-t_w)$. There are two types of people living in this economy, young and old. Young people work and earn labor income and consume an α fraction of income $c_{yt} = \alpha w_t$ and save $(1-\alpha)$ for their old age. The life time budget constraint is given by $c_{y,t} + \frac{c_{o,t}}{(1+r_{t+1})} = w_t(1-t_w)$. The old people earn interest in their asset and consume all of their income, $c_{ot} = a_t(1+r_t)(1-t_k)$. The capital stock of period *t* results from the saving of old people; $a_{t+1} = (1-\alpha)w_t$. Next periods capital stock equals the assets saved today as given by the equation of accumulation:

$$K_{t+1} = (1-\alpha)w_t(1-t_w) = (1-\alpha)(1-\beta)A_t k_t^{\beta}(1-t_w).$$

Aggregate saving equals total output minus the consumption of young and old, this also is the market clearing condition in this model $S_t = Y_t - Nc_{yt} - Nc_{ot} - Ng_t$. Saving equals investment in each period $S_t = I_t$ and investment adds to the capital stock $I_t = K_{t+1} - K_t$. The public sector balances $G_t = R_t = (1-\beta)A_t k_t^{\beta} t_w L_t + \beta A_t k_t^{\beta-1} t_k$. Studying the transitional dynamics of this model it is obvious that higher tax rates on wage and capital income not only reduce the level of welfare of both young and old generations but also reduce the amount of accumulation of the economy if the public goods do not contribute towards the production process.

Impacts of capital income taxes on growth can be even higher in the analytical framework of endogenous growth model. It is obvious if seen using a $y = Ak$; $f' = A = r(1+t)$ or $r = \frac{A}{(1+t)}$. Capital income tax reduces growth and accumulation as much as lowers the savings of households who face the higher taxes and lower rate of productivity of capital and may prefer to consume more in the current period rather than saving for future. Rebelo (1991) has found the welfare impacts of taxes to be more than 40 times higher in the endogenous model rather than in a standard neoclassical model.

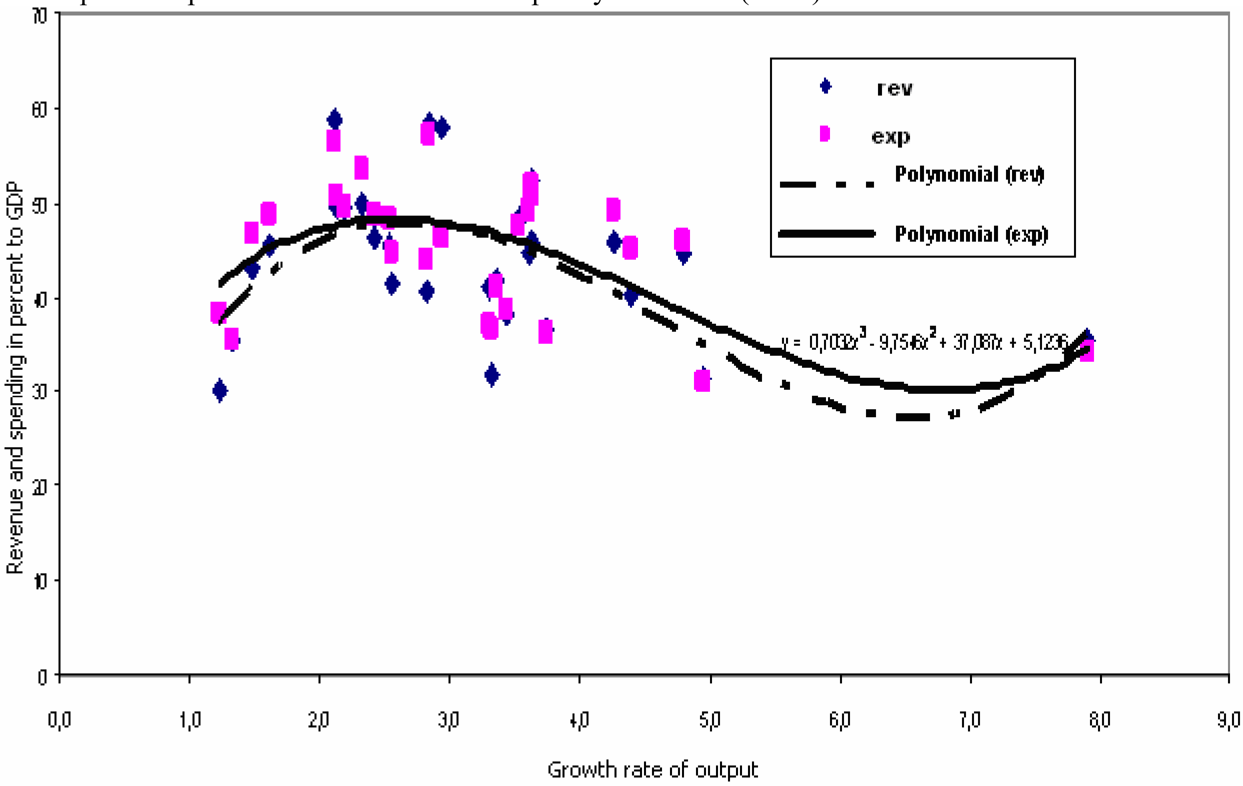
3. Empirical evidence

Above claims on size of public sector and growth are tested here using the real world data for OECD economies. A rank correlation analysis between the economic growth, ratios of public sector revenues and spending to GDP clearly establishes negative association between growth rates and size of the public sector in the study period, as shown in Table 1. These estimates clearly show negative correlation between growth rates and the ratios of revenue and spending to the GDP, whereas the correlation is as expected between revenue and spending. The larger the public sector, the smaller the marginal benefit of public spending will be and the better the probabilities that resources will have higher productivity in the private sector. There seem to be significant cross-country negative and positive correlations in tax rates and growth rates among 29 OECD economies, as reported in Tables A1 and A2 in the Appendix.

Table 1. Correlations between ranks of growth rates, revenue and spending

	Rank-growth	Rank-rev	Rank_spend
Rank-growth	1		
Rank-rev	-0.19022	1	
Rank_spend	-0.24028	0.900189	1

Model discussed thus far did not take account of public goods into consideration while evaluating the adverse consequences of tax revenue. The distortionary impacts of taxes can be compensated if resources are used well in providing the public goods positive externalities in consumption and production. More recent models have attempted to include public goods funded by tax revenue not only in the consumer's utility but also in the production function (Bergstrom, 2003; Dhillon et al., 2007). All these theoretical models are helpful in abstract reasoning but policy makers and practitioners require more elaborate assessment of the economy. Full general equilibrium analysis on how various forms of taxes affect an economy can be very complicated. Dynamic general equilibrium models are often solved numerically to assess impacts of public sector activities and policy choices on output, income, employment, labor supply, levels of welfare and distribution of income and wealth among households over years. These can be found in Fullerton, Shoven and Whalley (1983), Bovenberg (1989), Goulder and Summers (1989), Summers (1980), Rebelo (1991), Perroni (1995), Bhattarai (2008), Benabou (2002), Caucutt, Imrohoroglu and Kumar (2006).



Source: OECD.

Fig. 5. Growth rates, tax revenue and spending, 2004

3.1. Variations in the size and structure of revenue. OECD governments receive most of their revenue from direct taxes on personal or corporate income or indirect taxes on consumption of goods and services and their structure varies enormously across countries. Some rely more on income or corporate taxes, which are generally regarded more progressive as they are mostly paid by richer section of the society, while still many other countries rely on indirect value added taxes (VAT) on consumption of goods and services, which are considered more regressive as both rich and poor households pay equally on the basis of their consumption. Higher income taxes discourage labor supply and, hence, cause reduction in production; higher corporate taxes discourage investment and, hence, capital formation. Higher consumption taxes may distort incentives for saving. Given these considerations it is not unnatural to see significant variations across countries in the sources of revenue, as shown in Figure 2.

3.2. Panel data analysis. Panel data on growth rate and tax rates for 29 OECD countries are constructed from the OECD data set available from www.mimas.ac.uk/esds international. Details on growth rates and tax rates are provided for individual economies in by time series charts of growth rates and tax rates in the Appendix. Empirical analyses from these panel data in the form of regression of growth rate of OECD countries on their tax to GDP ratio are reported in Tables 3 to 5. The augmented Dickey-Fuller test suggests that both growth rate and tax rates are stationary variables.

Table 2. Unit root test for growth, tax rate and residual from panel regression of growth rate on tax rates

	Calculated ADF value	Lag length based on AIC criteria	Critical ADF value at 1% significance
Growth rate	-14.08**	0	-3.45
Tax rate	-4.346**	0	-3.45
Residual	-12.62**	2	-3.45

Table 3. Regression of growth rate on tax rates in OECD countries

	Coefficient	Std. error	t-value	t-prob
Tax ratio	-0.0047	0.0243	-0.1950	0.8460
Constant	3.0289	0.9303	3.2600	0.0010

No. of observations 434	No. of parameters	2
Constant: yes	Time dummies:	0
Number of individuals 29	(derived from year)	
Longest time series 15	[1991-2005]	
Shortest time series 14	(unbalanced panel)	

Wald (joint):	Chi^2(1) = 0.03796 [0.846]
Wald (dummy):	Chi^2(1) = 10.60 [0.001] **
AR(1) test:	N(0,1) = 3.152 [0.002] **
AR(2) test:	N(0,1) = 2.288 [0.022] *

This result also confirms that higher tax rate lowers the growth rate though such relation is not very strong and statistically insignificant. This implies real factors including the rate of capital formation, human capital and technology are more important for growth than the tax rates themselves as higher tax rates are associated with higher rate of public services. Negative effects of taxes are often compensated by positive effects of public goods, thus, leaving a very small net negative impact on growth.

Table 4. Regression of growth rate on tax rates in OECD countries (including time effect)

	Coefficient	Std. error	t-value	t-prob
Tax ratio	-0.0017	0.0218	-0.0784	0.9380
Constant	0.9078	1.1550	0.7860	0.4320
T1992	0.4453	0.6731	0.6620	0.5090
T1993	0.4943	0.8687	0.5690	0.5700
T1994	2.5328	0.8694	2.9100	0.0040
T1995	2.4819	1.0220	2.4300	0.0160
T1996	2.6169	0.8861	2.9500	0.0030
T1997	3.2636	0.8364	3.9000	0.0000
T1998	2.3037	1.0020	2.3000	0.0220
T1999	2.7919	0.8133	3.4300	0.0010
T2000	3.6102	0.7543	4.7900	0.0000
T2001	1.2111	0.8772	1.3800	0.1680
T2002	1.4863	0.8264	1.8000	0.0730
T2003	1.3629	0.9191	1.4800	0.1390
T2004	2.9380	0.8962	3.2800	0.0010
T2005	2.5971	0.9287	2.8000	0.0050

Sigma	2.5023	sigma^2	6.2616
R^2	0.1587		
RSS	2617.3432	TSS	3111.1233
No. of observations	434	No. of parameters	16

Constant: yes	Time dummies: 14
Number of individuals 29	(derived from year)
Longest time series 15	[1991-2005]
Shortest time series 14	(unbalanced panel)
Wald (joint): Chi^2(1) = 0.006154 [0.937]	
Wald (dummy): Chi^2(15) =180.9 [0.000] **	
Wald (time): Chi^2(14) = 158.7 [0.000] **	
AR(1) test: N(0,1) = 3.073 [0.002] **	
AR(2) test: N(0,1) = 2.309 [0.021] *	

Table 5. Regression of growth rate on tax rates in OECD countries(including country effects)

	Coefficient	Std. error	t-value	t-prob
Tax ratio	-0.0132	0.0193	-0.6850	0.4940
Constant	3.9046	0.8496	4.6000	0.0000
Austria	-1.1090	0.9424	-1.1800	0.2400
Belgium	-1.2648	0.9782	-1.2900	0.1970
Canada	-0.6339	0.8934	-0.7090	0.4780
Czech Republic	-1.8299	0.9291	-1.9700	0.0500
Denmark	-1.1454	0.9391	-1.2200	0.2230
Finland	-1.0652	0.9554	-1.1100	0.2650
France	-1.3691	0.9680	-1.4100	0.1580
Germany	-1.7442	0.9216	-1.8900	0.0590
Greece	-0.2546	0.9502	-0.2680	0.7890
Hungary	-0.8625	0.8888	-0.9700	0.3320
Iceland	-0.3296	0.8891	-0.3710	0.7110
Ireland	3.2379	0.9358	3.4600	0.0010
Italy	-2.2234	0.8925	-2.4900	0.0130
Japan	-2.4421	0.9378	-2.6000	0.0100
Korea	2.1868	0.8912	2.4500	0.0150
Luxembourg	1.0507	0.8924	1.1800	0.2400
Mexico	-0.3717	0.8971	-0.4140	0.6790
Netherlands	-1.0403	0.8906	-1.1700	0.2430
New Zealand	-0.1587	0.9121	-0.1740	0.8620
Norway	-0.1795	0.9048	-0.1980	0.8430
Poland	0.2156	0.9065	0.2380	0.8120
Portugal	-1.1491	0.9085	-1.2600	0.2070
Slovak Republic	0.5747	0.9388	0.6120	0.5410
Spain	-0.4848	0.8928	-0.5430	0.5870
Sweden	-1.1999	0.8998	-1.3300	0.1830
Switzerland	-2.3184	0.8915	-2.6000	0.0100
Turkey	0.5798	0.8881	0.6530	0.5140
United Kingdom	-0.9124	0.9198	-0.9920	0.3220
United States	-0.4294	0.8999	-0.4770	0.6330

R^2	0.2107
Wald (joint):	Chi^2(1) = 0.4686 [0.494]
Wald (dummy):	Chi^2(30) = 160.3 [0.000] **
AR(1) test:	N(0,1) = 5.249 [0.000] **
AR(2) test:	N(0,1) = 0.7718 [0.440]

Regression results reported in Table 4 support the proposition mentioned in the theoretical explanation part as country specific factors, relating to human and physical capital and technical progress, cause significant variation in growth rates not the tax rates, as positive contribution public services tend to compensate for the negative impacts of taxes.

Conclusion

The OECD countries with higher tax-GDP ratio generally had lower growth rates compared to other countries with lower size of the public sector during 1994-2006 period. These differences have historical roots and result in variation in collective preferences, constraints on choices of public goods and services and minimum standard of social insurance and their willingness to pay for them. They also influence the degree of economic freedom of private sector and the role of state in economic management. Impacts of taxes on accumulation and growth are assessed theoretically using neoclassical, optimal growth and overlapping generation models with empirical support based on rank correlation, panel growth regression and country pair correlations of growth rates and tax rates among the OECD countries. Net effect of taxes on growth is negative but very small as positive contributions of public services tend to counteract negative impacts of taxes. Real factors including the rate of capital formation, human capital and technology are more important for growth than the tax rates themselves as higher tax rates are associated with higher rate of public services. Negative effects of taxes are often compensated by positive effects of public goods, thus, leaving a very small net negative impact on growth.

References

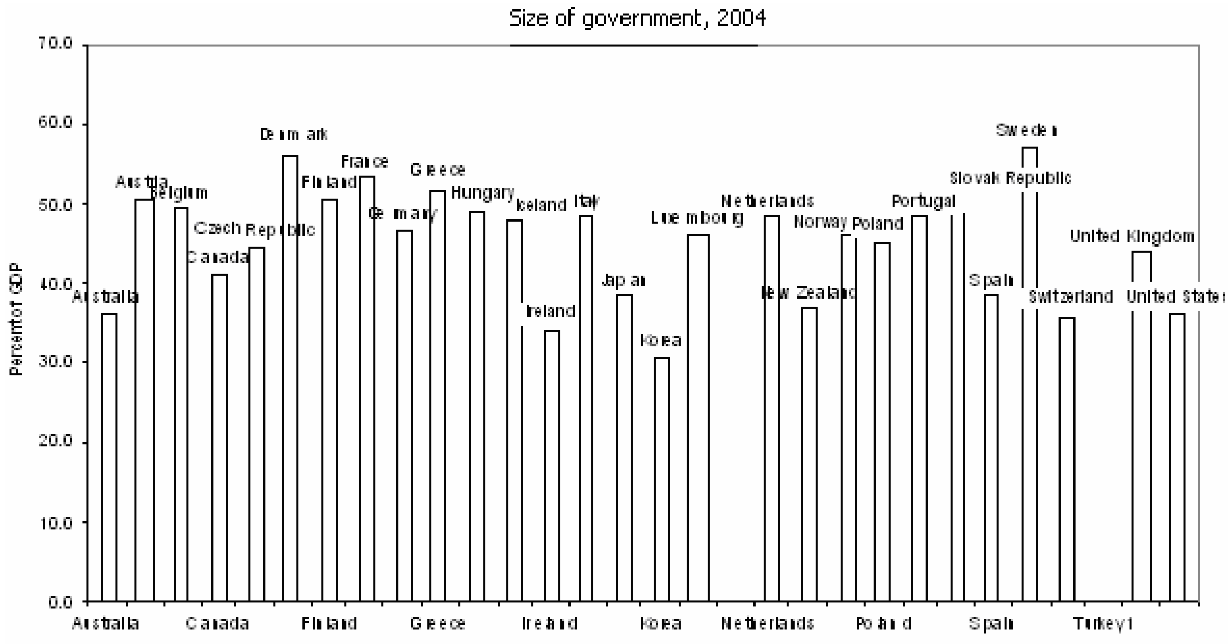
1. Atkinson A.B. (1971), Capital Taxes, the Redistribution of Wealth and Individual Savings, *The Review of Economic Studies*, 38, 2, 209-227.
2. Atkinson A.B., N.H. Stern (1974), Pigou, Taxation and Public Goods, *The Review of Economic Studies*, 41, 1, 119-128.
3. Atkinson A.B., J.E. Stiglitz (1980), Lectures on Public Economics, McGrawHill.
4. Auerbach A.J., L. Kotlikoff (1987), Dynamic Fiscal Policy, Cambridge University Press.
5. Bergstrom Ted C. (2003), Public Good in Production, *Journal of Public Economic Theory*.
6. Benabou R. (2002), Tax and education policy in a heterogeneous agent economy: What level of redistribution maximizes growth and efficiency, *Econometrica*, 70, 481-818.
7. Bhattarai K. (2008), Static and Dynamic Applied General Equilibrium Models Tax and Trade Policy Models of the UK Economy, Serials Publications, New Delhi.
8. Blomquist N. Sören (1985), Labour Supply in a Two-Period Model: The Effect of a Nonlinear Progressive Income Tax *The Review of Economic Studies*, 52, 3, 515-524.
9. Boadway Robin (1979), Long-Run Tax Incidence: A Comparative Dynamic Approach *The Review of Economic Studies*, 46, 3, 505-511.
10. Bovenberg L.A. (1989), The Effects of Capital Income Taxation on International Competitiveness and Trade Flows, *The American Economic Review*, 79, 5, 1045-1064.
11. Buchanan J.M. (1965), An Economic Theory of Clubs, Economica, 32, 125, 1-14.
12. Caucutt E.M, S. Imrohoroglu, K.B. Kumar (2006), Does the Progressivity of Income Taxes Matter for Human Capital and Growth? *Journal of Public Economic Theory*, 8, 1, 95-118.
13. Cass, D. (1965), Optimal Growth in an Aggregative Model of Capital Accumulation, *Review of Economic Studies* 32, 233-240.
14. Chen B.L. (2007), Factor taxation and labour supply in a dynamic one-sector growth model, *Journal of Economic Dynamics and Control*, 31, 3941-3964.
15. Cummins J.G., K.A. Hassett, R.G. Hubbard (1996), Tax reform and investment: A cross country Comparison, *Journal of Public Economics*, 62, 237-273.
16. Dhillon A., C. Perroni, K. Scharf (1999), Implementing tax coordination, *Journal of Public Economics*, 72, 243-268.
17. Di Tella R., R. MacCulloch (2006), Europe vs. America: Institutional hysteresis in a simple normative model, *Journal of Public Economics*, 90, 2161-2186.
18. Feldstein M. (1974), Incidence of Capital Income Tax in a Growth Economy with Varying Saving Rates, *Review of Economic Studies*, 41, 4, 505-513.
19. Fullteron D., G. Heutel (2007), The General equilibrium incidence of environmental taxes, *Journal of Public Economics*, 91, 571-591.
20. Fullerton, D., J. Shoven, J. Whalley (1983), Dynamic General Equilibrium Impacts of Replacing the US Income tax with a Progressive Consumption Tax, *Journal of Public Economics* 38, 265-96.
21. Goulder, L.H., L.H. Summers (1989), Tax Policy, Asset Prices, and Growth: A General Equilibrium Analysis, *Journal of Public Economics*, 38, 265-296.
22. Harberger A.C. (1962), The Incidence of Corporate Income Tax, *Journal of Political Economy*, 17, 3, 215-140.
23. Judd K.L. (1999), Optimal taxation and spending in general competitive growth models, *Journal of Public Economics*, 71, 1-26.
24. King R.G. and S.T. Rebelo (1993), Transitional Dynamics and Economic Growth in the Neoclassical Model, *The American Economic Review*, 83, 4, 908-931.
25. Krueckner J.K. (2006), Fiscal federalism and economic growth, *Journal of Public Economics*, 90, 2107-2120.
26. Mirlees, J.A. (1971), An exploration in the theory of optimum income taxation, *Review of Economic Studies*, 38, 175-208.
27. Pigou A.C. (1947), The range of government expenditure, A Study in Public Finance, Macmillan, 30-44, in R.W. Haughton ed. (1970), Public Finance Selected Readings, Penguin Books.

28. Perroni, C. (1995), Assessing the Dynamic Efficiency Gains of Tax Reform When Human Capital is Endogenous, *International Economic Review* 36, 907-925.
29. Rebelo, S. (1991), Long-run Policy Analysis and Long-run Growth, *Journal of Political Economy* 99, 500-521.
30. Rust J. and C. Phelan (1997). How social security and medicate affect retirement behaviour in a world incomplete markets, Econometrica, 65, 4, 781-831.
31. Samuelson P.A. (1954), Pure Theory of Public Expenditure, *Review of Economic Statistics*, 36, 387-9.
32. Summers, L.H. (1980), Capital Taxation and Accumulation in a Life Cycle Growth Model, *American Economic Review* 71, 533-44.
33. Tavares J. (2004), Does right or left matter? Cabinets, credibility and fiscal adjustments, *Journal of Public Economics*, 88, 2447-2468.
34. Uzawa, H. (1962), On a Two-Sector Model of Economic Growth, *Review of Economic Studies* 29, 40-47.
35. Wagstaff A. et al. (1999), Redistributive effect, progressivity, and differential tax treatment: personal income taxes in twelve OECD countries, *Journal of Public Economics*, 72, 73-98.
36. Whalley J. (1975), "A General Equilibrium Assessment of the 1973 United Kingdom tax reform", *Economica*, 42, 166, 139-161.

Appendix

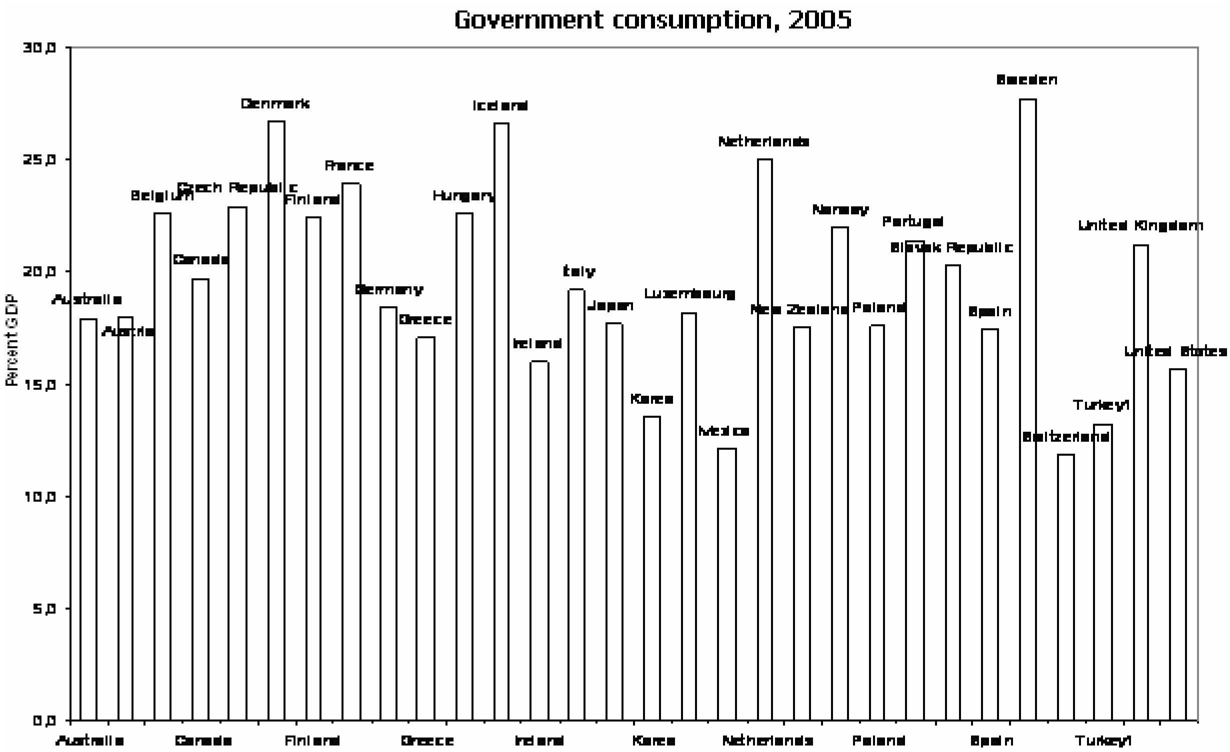
Table 1. Ranking by growth rates of output and the ratios of revenue and spending to GDP (OECD 2004)

	Growth rate 1994-2004	Revenue ratio	Spending ratio	Rank on growth	Rank on revenue	Rank on spending
Ireland	7.9	35.6	34.2	28	3	2
Korea	4.9	31.3	30.9	27	1	1
Luxembourg	4.8	44.8	45.9	26	12	11
Poland	4.4	40.2	45	25	6	10
Slovak Republic	4.3	45.7	49	24	14	17
Australia	3.7	36.6	36.2	23	4	3
Finland	3.6	52.5	50.7	22	21	20
Greece	3.6	46	52	21	15	21
Hungary	3.6	44.6	48.9	20	11	16
Iceland	3.5	48.1	47.6	19	17	13
Spain	3.4	38.4	38.6	18	5	6
Canada	3.4	41.7	41.1	17	10	7
United States	3.3	31.9	36.5	16	2	4
New Zealand	3.3	41.2	37	15	8	5
Norway	2.9	57.9	46.4	14	22	12
Sweden	2.8	58.3	57.3	13	23	24
United Kingdom	2.8	40.8	43.9	12	7	8
OECD total	2.6					
Czech Republic	2.6	41.5	44.6	10	9	9
Portugal	2.5	45.4	48.4	9	13	14
G7	2.5					
Netherlands	2.4	46.2	48.6	7	16	15
France	2.3	49.8	53.4	6	20	22
Euroarea	2.3					
Belgium	2.2	49.3	49.3	4	18	18
EU-15	2.2					
Austria	2.1	49.3	50.6	2	18	19
Denmark	2.1	58.9	56.3	1	24	23
Italy	1.6	45.4	48.5	4	16	18
Germany	1.5	43.2	46.8	3	13	15
Switzerland	1.3	35.6	35.5	2	4	3
Japan	1.2	30.3	38.2	1	1	7



Source: OECD.

Fig. 1. Ratio of public spending to GDP among OECD countries



Source: OECD.

Fig. 2. Ratio of government consumption to GDP among OECD countries

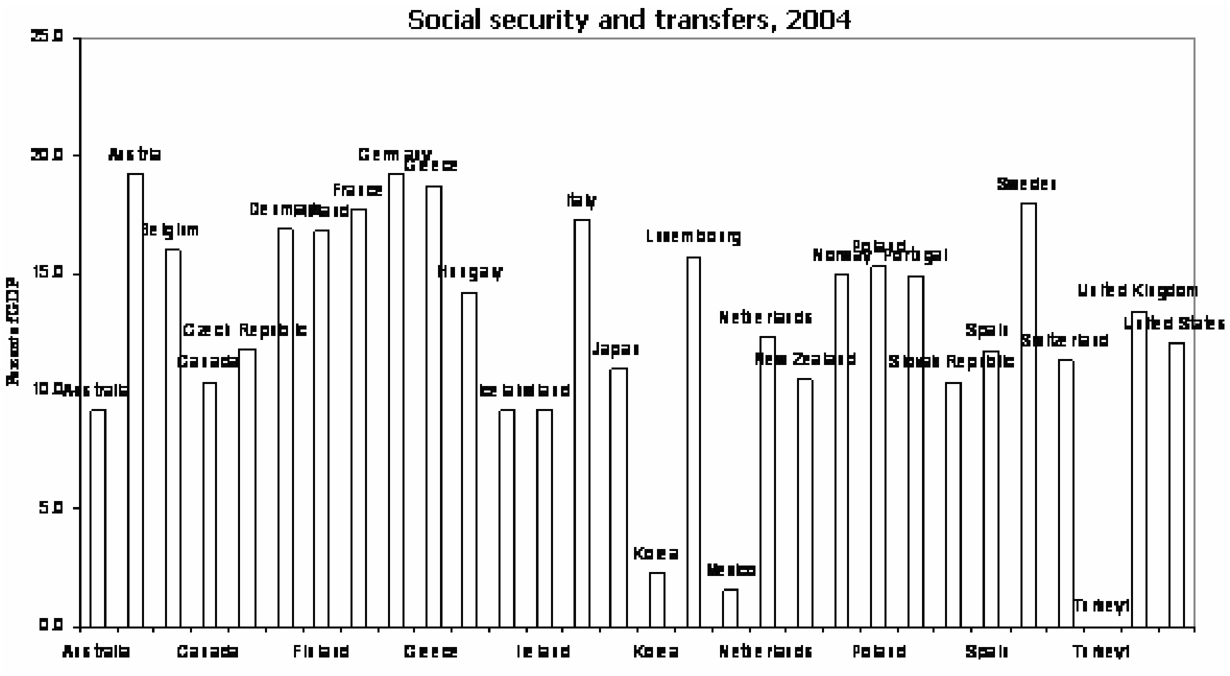


Fig. 3. Ratio of social security spending to GDP among OECD countries

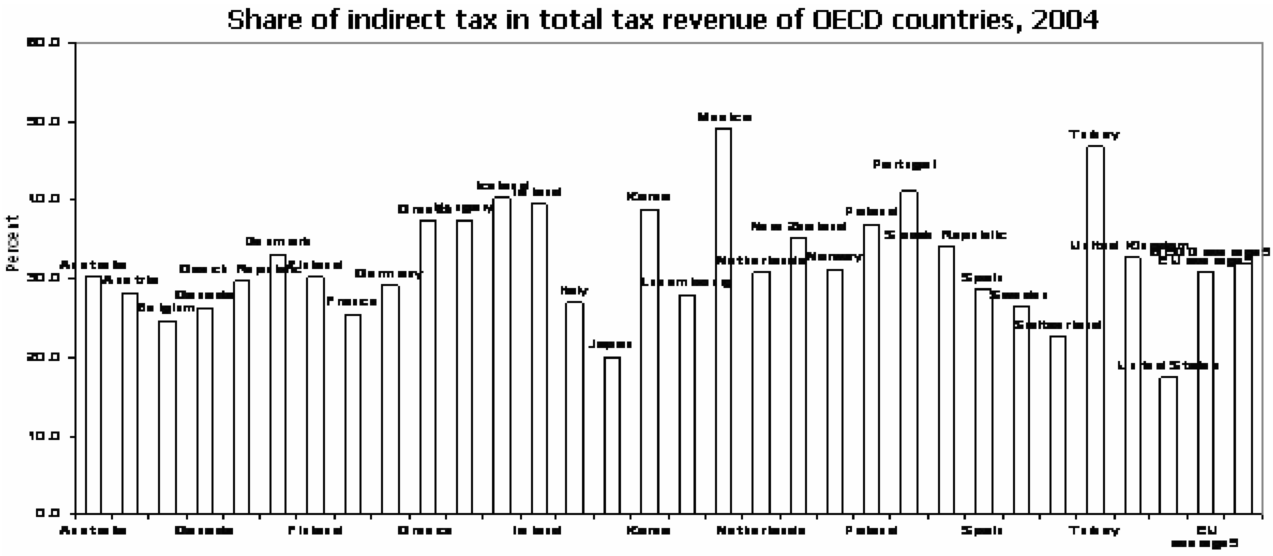


Fig. 4. Ratio of revenue to GDP among OECD countries

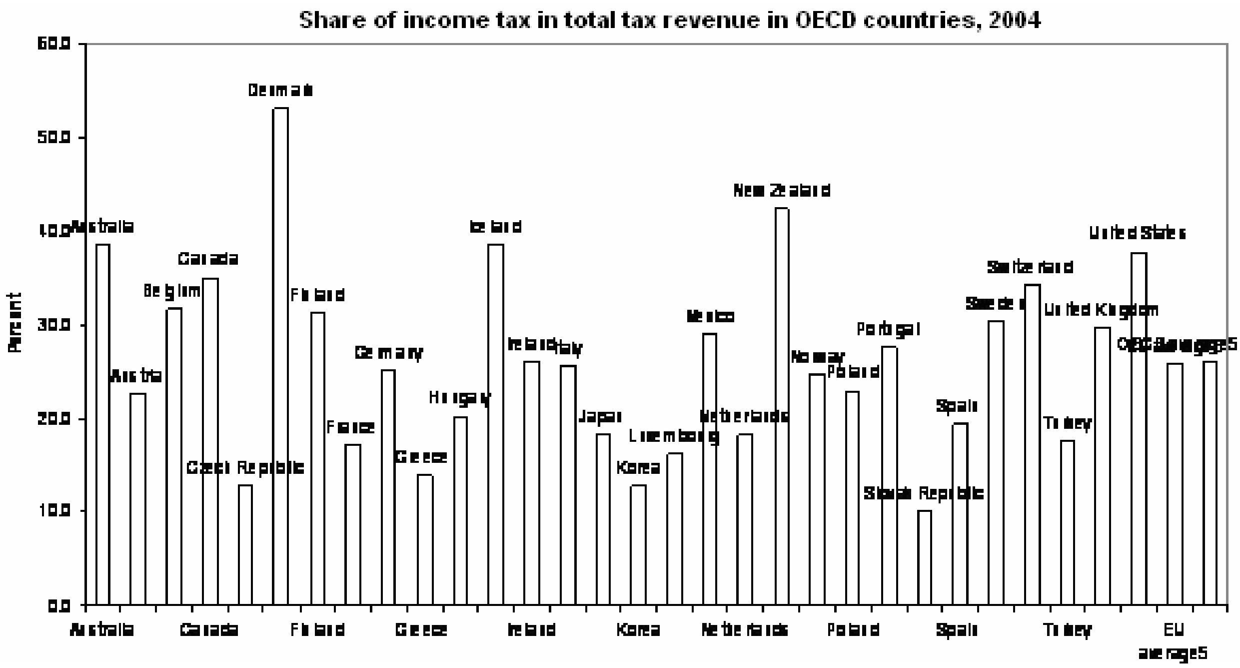


Fig. 5. Ratio of revenue to GDP among OECD countries

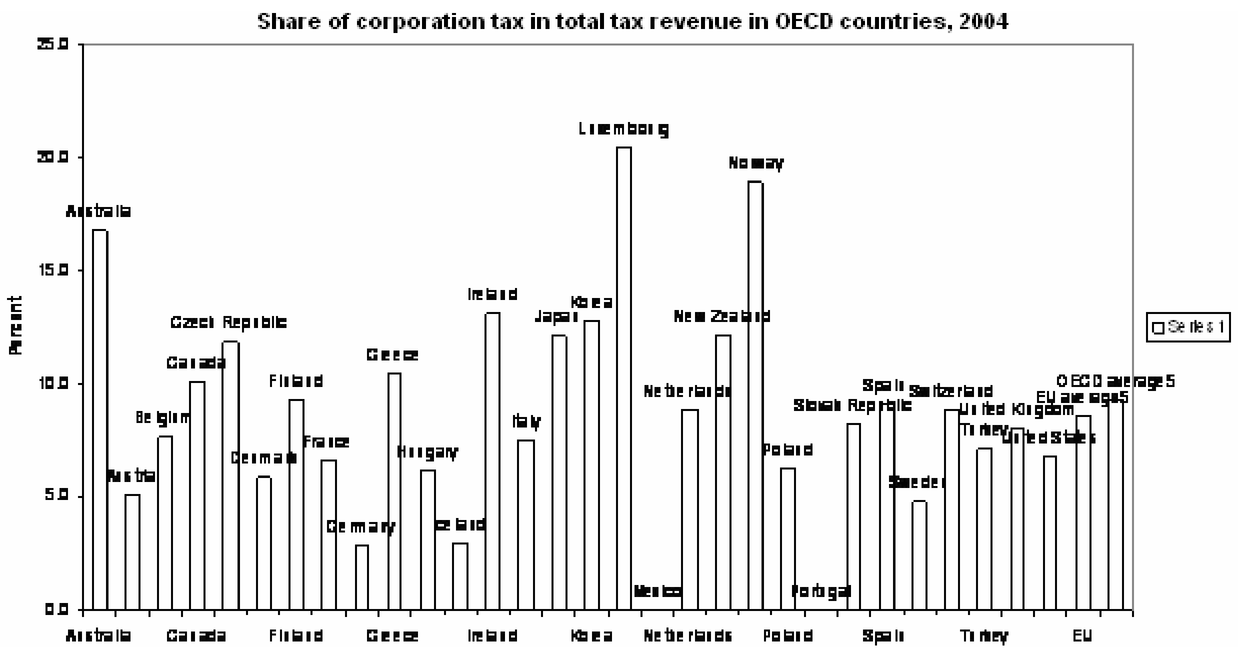
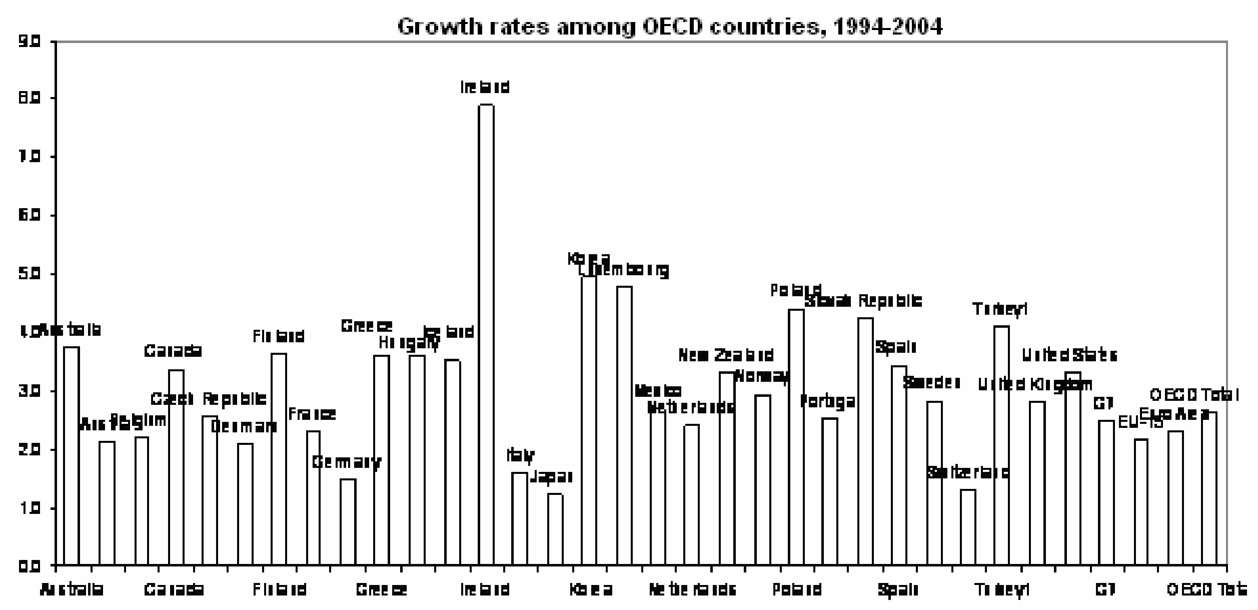


Fig. 6. Corporation tax among OECD countries



Source: OECD.

Fig. 7. Difference in growth rates among OECD countries

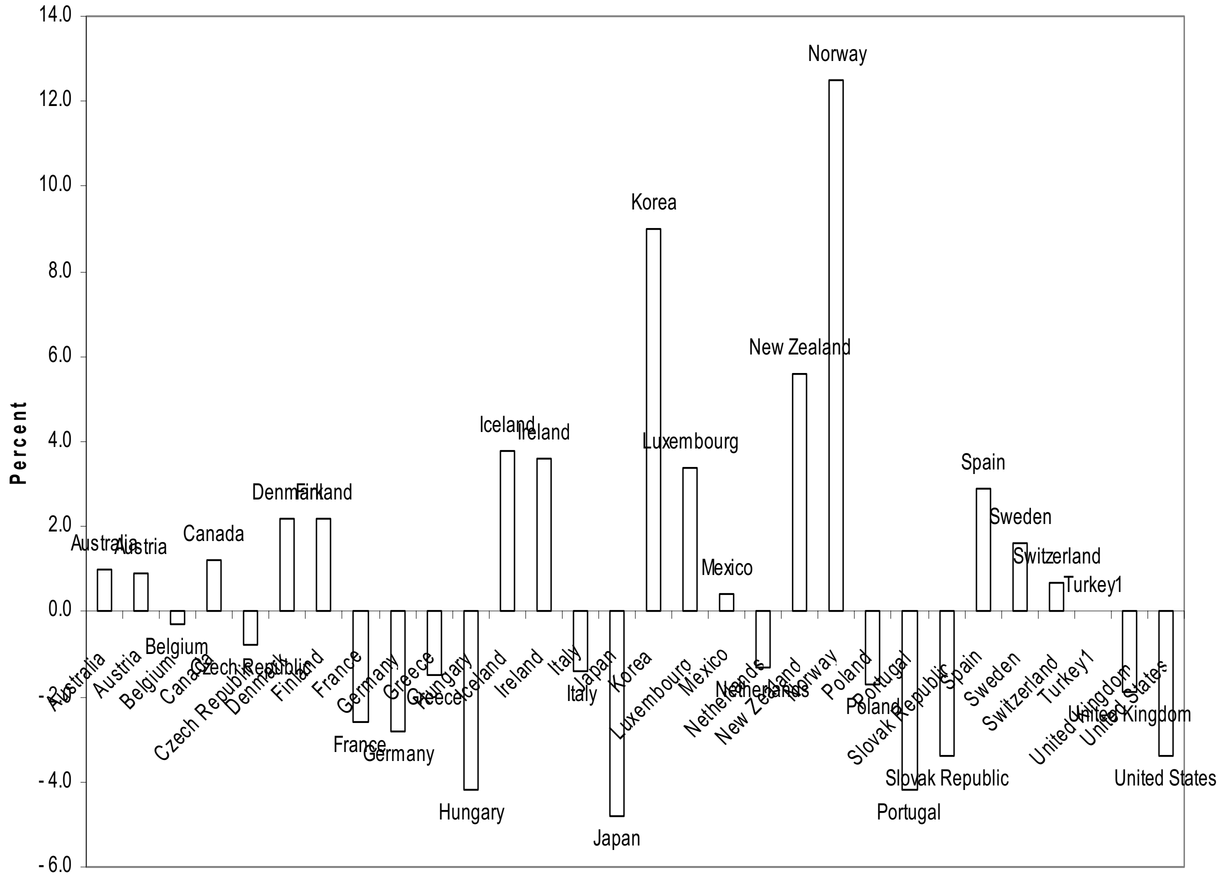


Fig. 8. Budget surplus and deficit among OECD countries

Table A1. Correlation in tax rates among OECD countries

	Australia	Austria	Belgium	Canada	Czech Republic	Denmark	Finland	France	Germany	Greece	Hungary	Iceland	Ireland	Italy	Japan	Korea
Australia	1,000															
Austria	-0,292	1,000														
Belgium	0,205	0,615	1,000													
Canada	-0,056	0,652	0,747	1,000												
Czech Republic	-0,389	0,370	-0,312	-0,018	1,000											
Denmark	0,537	-0,823	-0,302	-0,506	-0,710	1,000										
Finland	0,523	-0,529	0,238	0,169	-0,548	0,568	1,000									
France	-0,295	-0,571	-0,849	-0,460	0,013	0,333	-0,127	1,000								
Germany	-0,177	0,893	0,812	0,811	0,188	-0,741	-0,231	-0,685	1,000							
Greece	-0,458	0,859	0,473	0,752	0,505	-0,846	-0,403	-0,265	0,792	1,000						
Hungary	-0,357	0,248	0,374	0,400	-0,439	-0,079	-0,013	-0,023	0,437	0,304	1,000					
Iceland	-0,497	0,911	0,441	0,620	0,574	-0,955	-0,533	-0,404	0,806	0,901	0,138	1,000				
Ireland	0,580	-0,925	-0,425	-0,575	-0,454	0,896	0,641	0,320	-0,804	-0,900	-0,315	-0,950	1,000			
Italy	0,471	-0,742	-0,115	-0,217	-0,406	0,762	0,780	0,091	-0,495	-0,736	-0,116	-0,789	0,842	1,000		
Japan	-0,623	0,697	0,039	0,278	0,459	-0,753	-0,760	0,068	0,503	0,724	0,229	0,786	-0,855	-0,844	1,000	
Korea	-0,287	0,970	0,493	0,501	0,364	-0,807	-0,636	-0,484	0,802	0,811	0,193	0,878	-0,906	-0,837	0,751	1,000
Luxembourg	0,221	0,255	0,318	0,507	-0,196	0,010	0,073	0,057	0,299	0,421	0,298	0,070	-0,165	-0,125	0,061	0,245
Mexico	0,247	-0,892	-0,484	-0,405	-0,188	0,676	0,654	0,430	-0,756	-0,692	-0,244	-0,774	0,830	0,771	-0,733	-0,938
Netherlands	0,674	-0,848	-0,351	-0,588	-0,398	0,841	0,613	0,169	-0,739	-0,911	-0,418	-0,897	0,974	0,814	-0,841	-0,816
New Zealand	0,206	-0,939	-0,627	-0,550	-0,096	0,720	0,544	0,565	-0,847	-0,744	-0,313	-0,833	0,861	0,759	-0,655	-0,941
Norway	-0,229	-0,027	-0,250	-0,395	-0,077	0,082	-0,565	0,255	-0,068	-0,155	0,366	-0,149	-0,096	-0,235	0,183	0,048
Poland	0,257	-0,846	-0,436	-0,310	-0,051	0,581	0,644	0,420	-0,649	-0,614	-0,325	-0,704	0,787	0,820	-0,692	-0,910
Portugal	-0,544	0,765	0,255	0,618	0,392	-0,771	-0,572	-0,017	0,680	0,898	0,404	0,806	-0,892	-0,792	0,824	0,748
Slovak Republic	-0,134	-0,014	0,155	0,109	-0,528	0,174	0,091	-0,061	0,091	-0,129	0,476	-0,049	-0,024	0,018	-0,027	-0,044
Spain	-0,285	0,488	0,508	0,820	0,275	-0,560	0,224	-0,336	0,627	0,655	0,341	0,572	-0,482	-0,111	0,212	0,344
Sweden	0,372	0,491	0,905	0,610	-0,175	-0,233	0,270	-0,907	0,713	0,266	0,136	0,310	-0,243	0,074	-0,190	0,363
Switzerland	-0,033	0,521	0,892	0,795	-0,066	-0,400	0,337	-0,729	0,748	0,540	0,313	0,500	-0,434	-0,049	0,060	0,349
Turkey	-0,643	0,370	-0,175	0,178	0,311	-0,413	-0,575	0,266	0,217	0,475	0,423	0,380	-0,506	-0,436	0,459	0,342
United Kingdom	-0,328	-0,320	-0,656	-0,219	0,661	-0,122	-0,121	0,553	-0,391	-0,023	-0,386	-0,066	0,104	0,020	0,010	-0,326
United States	0,661	-0,786	-0,168	-0,486	-0,579	0,867	0,693	0,032	-0,632	-0,904	-0,260	-0,876	0,933	0,859	-0,885	-0,783
EU15 average	0,589	-0,123	0,570	0,510	-0,432	0,274	0,839	-0,431	0,214	-0,089	0,082	-0,235	0,335	0,622	-0,609	-0,266
OECD average	-0,148	0,508	0,586	0,943	0,036	-0,443	0,251	-0,258	0,675	0,721	0,466	0,511	-0,481	-0,146	0,247	0,371

	Luxembourg	Mexico	Netherlands	New Zealand	Norway	Poland	Portugal	Slovak Republic	Spain	Sweden	Switzerland	Turkey	United Kingdom	United States	EU15 average	OECD average
Luxembourg	1,000															
Mexico	-0,287	1,000														
Netherlands	-0,226	0,736	1,000													
New Zealand	-0,228	0,929	0,779	1,000												
Norway	0,000	-0,172	-0,147	-0,097	1,000											
Poland	-0,140	0,899	0,714	0,917	-0,229	1,000										
Portugal	0,416	-0,670	-0,939	-0,683	0,182	-0,617	1,000									
Slovak Republic	-0,126	-0,066	-0,077	-0,104	0,262	-0,200	0,069	1,000								
Spain	0,174	-0,137	-0,507	-0,327	-0,529	-0,118	0,460	-0,088	1,000							
Sweden	0,216	-0,367	-0,134	-0,499	-0,232	-0,247	0,048	0,074	0,393	1,000						
Switzerland	0,157	-0,278	-0,404	-0,440	-0,428	-0,210	0,286	0,096	0,701	0,775	1,000					
Turkey	0,107	-0,205	-0,626	-0,286	0,409	-0,327	0,613	0,005	0,303	-0,271	-0,109	1,000				
United Kingdom	-0,171	0,469	0,011	0,505	0,042	0,516	0,110	-0,268	0,013	-0,537	-0,347	0,323	1,000			
United States	-0,230	0,687	0,959	0,681	-0,149	0,635	-0,954	0,062	-0,419	0,022	-0,251	-0,635	-0,186	1,000		
EU15 average	0,363	0,279	0,355	0,170	-0,523	0,401	-0,294	-0,011	0,420	0,660	0,565	-0,469	-0,267	0,454	1,000	
OECD average	0,537	-0,236	-0,535	-0,359	-0,426	-0,165	0,601	0,047	0,884	0,411	0,700	0,247	-0,066	-0,463	0,507	1,000

Table A2. Correlation in growth rates among OECD countries

	Australia	Austria	Belgium	Canada	Czech Republic	Denmark	Finland	France	Germany	Greece	Hungary	Iceland	Ireland	Italy	Japan	Korea	Luxembourg	Mexico	Netherlands	New Zealand	Norway	Poland	Portugal	Slovak Republic	Spain	Sweden	Switzerland	Turkey	United Kingdom	United States	EU15 average	OECD average
2002	27,7	47,1	56,3	32,1	42,9	42,6	45,9	49,8	53,6	37,7	53,7	28,4	24,5	46	30,5	16,1	33,6	17,5	37,4	19,5	38,6	42,9	36,6	42,5	39,1	47,8	30,1	42,5	31,9	29,4	42	37,5
2003	28	47,4	55,7	32	43,2	42,6	45	49,8	51,5	37,7	50,8	29,2	24,2	45	27,4	16,3	34,1	18,1	37,1	19,7	38,1	43,1	36,8	42,9	38,5	48,2	29,7	42,2	33,3	29,2	41,8	37,2
2004	28	47,5	55,4	32	43,5	41,3	44,5	49,8	53,3	38,3	51,8	29,4	26,2	45,4	27,4	17,2	34,6	16,2	38,6	20	38,1	43,3	36,8	42,5	38,7	48,4	29,4	42,8	33,4	29,1	42,1	37,4
2005	28,3	47,4	55,4	31,6	43,8	41,4	44,6	50,1	51,8	38,8	50,5	29	25,7	45,4	27,7	17,3	35,3	18,2	38,6	20,5	37,3	43,6	36,2	38,3	39	47,9	29,5	42,7	33,5	29,1	42,1	37,3
Australia	1,000																															
Austria	-0,292	1,000																														
Belgium	0,205	0,615	1,000																													
Canada	-0,056	0,652	0,747	1,000																												
Czech Republic	-0,389	0,370	-0,312	-0,018	1,000																											
Denmark	0,537	-0,823	-0,302	-0,506	-0,710	1,000																										
Finland	0,523	-0,529	0,238	0,169	-0,548	0,568	1,000																									
France	-0,295	-0,571	-0,849	-0,460	0,013	0,333	-0,127	1,000																								
Germany	-0,177	0,893	0,812	0,811	0,188	-0,741	-0,231	-0,685	1,000																							
Greece	-0,458	0,859	0,473	0,752	0,505	-0,846	-0,403	-0,265	0,792	1,000																						
Hungary	-0,357	0,248	0,374	0,400	-0,439	-0,079	-0,013	-0,023	0,437	0,304	1,000																					
Iceland	-0,497	0,911	0,441	0,620	0,574	-0,955	-0,533	-0,404	0,806	0,901	0,138	1,000																				
Ireland	0,580	-0,925	-0,425	-0,575	-0,454	0,896	0,641	0,320	-0,804	-0,900	-0,315	-0,950	1,000																			
Italy	0,471	-0,742	-0,115	-0,217	-0,406	0,762	0,780	0,091	-0,495	-0,736	-0,116	-0,789	0,842	1,000																		
Japan	-0,623	0,697	0,039	0,278	0,459	-0,753	-0,760	0,068	0,503	0,724	0,229	0,786	-0,855	-0,844	1,000																	
Korea	-0,287	0,970	0,493	0,501	0,364	-0,807	-0,636	-0,484	0,802	0,811	0,193	0,878	-0,906	-0,837	0,751	1,000																
Luxembourg	0,221	0,255	0,318	0,507	-0,196	0,010	0,073	0,057	0,299	0,421	0,298	0,070	-0,165	-0,125	0,061	0,245	1,000															
Mexico	0,247	-0,892	-0,484	-0,405	-0,188	0,676	0,654	0,430	-0,756	-0,692	-0,244	-0,774	0,830	0,771	-0,733	-0,938	-0,287	1,000														
Netherlands	0,674	-0,848	-0,351	-0,588	-0,398	0,841	0,613	0,169	-0,739	-0,911	-0,418	-0,897	0,974	0,814	-0,841	-0,816	-0,226	0,736	1,000													
New Zealand	0,206	-0,939	-0,627	-0,550	-0,096	0,720	0,544	0,565	-0,847	-0,744	-0,313	-0,833	0,861	0,759	-0,655	-0,941	-0,228	0,929	0,779	1,000												
Norway	-0,229	-0,027	-0,250	-0,395	-0,077	0,082	-0,565	0,255	-0,068	-0,155	0,366	-0,149	-0,096	-0,235	0,183	0,048	0,000	-0,172	-0,147	-0,097	1,000											
Poland	0,257	-0,846	-0,436	-0,310	-0,051	0,581	0,644	0,420	-0,649	-0,614	-0,325	-0,704	0,787	0,820	-0,692	-0,910	-0,140	0,899	0,714	0,917	-0,229	1,000										
Portugal	-0,544	0,765	0,255	0,618	0,392	-0,771	-0,572	-0,017	0,680	0,898	0,404	0,806	-0,892	-0,792	0,824	0,748	0,416	-0,670	-0,939	-0,683	0,182	-0,617	1,000									
Slovak Republic	-0,134	-0,014	0,155	0,109	-0,528	0,174	0,091	-0,061	0,091	-0,129	0,476	-0,049	-0,024	0,018	-0,027	-0,044	-0,126	-0,066	-0,077	-0,104	0,262	-0,200	0,069	1,000								
Spain	-0,285	0,488	0,508	0,820	0,275	-0,560	0,224	-0,336	0,627	0,655	0,341	0,572	-0,482	-0,111	0,212	0,344	0,174	-0,137	-0,507	-0,327	-0,529	-0,118	0,460	-0,088	1,000							