ELSEVIER

Journal of Public Economics 89 (2005) 1027–1043

JOURNAL OF PUBLIC ECONOMICS

www.elsevier.com/locate/econbase

Tax structure and economic growth

Young Lee[a,*], Roger H. Gordon[b]

[a]*Hanyang University, Seoul, South Korea*
[b]*University of California, San Diego, CA, USA*

Received 11 March 2003; received in revised form 20 July 2004; accepted 27 July 2004
Available online 25 September 2004

Abstract

Past theoretical work predicts that higher corporate tax rates should decrease economic growth rates, while the effects of high personal tax rates are less clear. In this paper, we explore how tax policies in fact affect a country's growth rate, using cross-country data during 1970–1997. We find that statutory corporate tax rates are significantly negatively correlated with cross-sectional differences in average economic growth rates, controlling for various other determinants of economic growth, and other standard tax variables. In fixed-effect regressions, we again find that increases in corporate tax rates lead to lower future growth rates within countries. The coefficient estimates suggest that a cut in the corporate tax rate by 10 percentage points will raise the annual growth rate by one to two percentage points.

Keywords: Tax structure; Economic growth; Regressions

1. Introduction

During the past several decades, there has been an enormous amount of work in public finance documenting myriad ways in which taxes distort the allocation decisions of firms and individuals.[1] In comparison, there has been much less work, at least in public finance,

* Corresponding author. Tel.: +82 2 2290 1023.
E-mail address: younglee@hanyang.ac.kr (Y. Lee).

[1] For a recent overview of these contributions, see Feldstein (2002).

0047-2727/$ - see front matter © 2004 Elsevier B.V. All rights reserved.
doi:10.1016/j.jpubeco.2004.07.002

documenting effects of the tax structure on the economy's overall growth rate. Of course, within a neoclassical framework, as in Solow (1970), growth simply depends on the accumulation of capital and labor, so that the existing empirical work studying tax effects on investment and labor supply does capture the relevant effects on growth. In this framework, however, there would be no effects of taxes on total factor productivity.

The more recent literature on endogenous growth, however, suggests that positive externalities omitted from the traditional neoclassical models play an important role in explaining long-run growth. There could be a variety of possible sources of these externalities. There is a strong presumption that R&D and entrepreneurial activity more generally provide such positive spillovers.[2] Lucas (1988) emphasizes that education can generate important positive externalities, since individuals learn by observing the behavior of others.[3] Alternatively, De Long and Summer (1991) report evidence that equipment investment may generate important positive spillovers.[4]

What government policies have been effective at correcting for these externalities, thereby encouraging more productivity growth? There is clear evidence that patent protection and R&D subsidies affect the amount of R&D activity. Tax policy can also be used to affect the amount of entrepreneurial activity more broadly. For example, Gentry and Hubbard (2000) provide evidence that a progressive personal tax structure discourages risk-taking. Gordon (1998) shows that the option to incorporate means that a low corporate tax rate *relative* to personal tax rates encourages risk-taking. Cullen and Gordon (2002) explore the many potential effects of the tax system on entrepreneurial activity, and find strong empirical support for these tax effects using US individual income tax return data during 1964–1993.

If entrepreneurial activity is an important source of economic growth, as argued by Schumpeter (1942), then these same characteristics of the tax law should also generate a higher growth rate. The objective of the next section is to enumerate these and other ways in which taxes can affect the growth rate.

The main objective of the paper is then to test for these effects of the tax structure on the economic growth rate, using both cross-sectional and time-series information about country growth rates between 1970 and 1997. As seen in Section 2, the theory suggests a particular focus on the corporate tax rate, since the net effects of personal income tax rates are less clear.[5] The empirical strategy is described in Section 3, and the data and regression results are discussed in Sections 4 and 5. While our paper finds that various measures of personal tax rates are not significantly associated with economic growth, we do find a significant effect of corporate tax rates on economic growth, even after controlling for other determinants/covariates of economic growth. The estimated effect is quite similar in

[2] See Hall (1995) for evidence that the social return to R&D is much above the private return.

[3] These spillovers can occur across generations, through learning more from better-educated teachers, or within a generation by learning more from better educated colleagues. See Moretti (in press) for recent evidence on this latter effect.

[4] Of course, the traditional "accelerator" model of investment forecasts that investment will be related to the growth rate in the economy, though here the direction of causation is the reverse.

[5] Even if high personal tax rates may encourage entrepreneurial activity, they may be detrimental to economic growth for many other reasons.

the cross-sectional and time-series estimates, and with or without fixed effects in the time-series specification.

Any inference that this effect of the corporate tax rate is due to effects on entrepreneurial activity of course is speculative. Consistent with this interpretation, however, we provide evidence that a low corporate rate leads to a fall in personal income tax revenue, in spite of the higher growth rate. We presume this occurs because people reduce their time as employees, where income is subject to the personal tax, and instead become entrepreneurs, generating corporate tax revenue and perhaps personal tax losses.

We conclude the paper with a summary and discussion of policy implications in Section 6.

2. Taxes and economic growth: theory

Past research has enumerated a wide variety of ways in which the tax structure can affect observed economic growth rates. In this section, we summarize these effects, focusing in turn on particular subsets of this literature. Since the objective here is to motivate the empirical work, we focus on those effects that can be measured given the limited information we have about tax structures in a large panel data set of countries.

2.1. Taxes and factor accumulation

In a neoclassical setting, growth simply depends on the accumulation of physical and human capital. In the long-run, any given tax structure generates an equilibrium capital/labor ratio and an equilibrium level of education per worker. Any further growth in per-capita output simply arises from an exogenous rate of technical change. There should be no permanent effects of the tax structure on the growth rate in per capita output, regardless of the size of the misallocations generated by the tax structure.

Changes in tax policy, however, can generate changes in these equilibrium values, generating transitory growth effects. These transition periods can be measured in decades, however. An increase in the years of education chosen by new entrants to the labor force, for example, will have fully changed the average education for the labor force as a whole only after the first entrants following the policy change have reached retirement age. Tax effects on the equilibrium capital stock can also take some period of time to be felt, due to adjustment costs to new investment in an open economy or due to the limited elasticity of savings rates in a closed economy.

What *changes* in tax policy then generate such increases in investment in physical and human capital? As seen in Hall and Jorgenson (1967) and much subsequent literature on taxes and rates of capital investment, low current effective tax rates on new investment suggest faster short-run growth, due to an investment boom in response to the temporarily lower tax rates. Our best available proxy for this is periods with a lower corporate income tax rate.

Tax effects on investment in *human* capital are more complicated. Trostel (1993) demonstrates that a constant labor income tax rate does not affect educational incentives per se, since the government then shares equally in the foregone earnings and the future

return from education. But, as Heckman et al., (1998) emphasize, a progressive labor income tax discourages education, since the taxes saved while in school are then more than offset in present value by the future taxes due on the resulting extra earnings. In addition, however, any tax on the return to savings lowers the individual's discount rate, leading to an increase in education. Furthermore, school expenditures are one of the largest uses of public funds, so that higher tax rates provide the resources for more education. Forecasted effects of the personal income tax on education are then not clear-cut. In the empirical work, we control directly for rates of school attendance, so that the estimated effects of the tax structure should not include effects on rates of education.

Growth rates can also be higher during periods when public infrastructure increases relative to other factor inputs. This should occur when government revenue is unusually high. We will control for government revenue relative to GDP to capture such effects.

In addition, if tax policy is used to respond to business-cycle fluctuations, this could also induce a short-run correlation between tax rates and the growth rate.[6] To try to avoid any short-run business-cycle effects, we will focus on the links between tax rates and average growth rates over a longer period of time so that these short-run effects will tend to average out.

2.2. Taxes in an endogenous growth framework

The more recent endogenous growth literature provides models forecasting permanent growth, even with a stable tax structure, due to externalities generated through the accumulation of physical or human capital. While effects on growth can be permanent, the key issue remains the current incentives to investment in physical or human capital. During periods of greater incentives, growth rates should be faster. We will not be using a long enough time period to judge whether effects on growth die out after perhaps several decades (as in the neoclassical model), or are permanent as in an endogenous growth setting.

2.3. Taxes and rates of technical change

Much earlier than this endogenous growth literature, Schumpeter (1942) emphasized the role of entrepreneurial activity in generating new ideas that raise productivity. Here, rather than investments in physical or human capital per se generating growth, explicit investments by entrepreneurs in the creation of new ideas generate growth.

How does the tax structure affect the rate of entrepreneurial activity, and so the rate of creation of new ideas? There is now a recent literature investigating this question.[7]

The paper by Cullen and Gordon (2002) provides the most general analysis so far, and shows that there are several possible routes through which taxes can affect the amount of entrepreneurial risk-taking. To begin with, there is a tax encouragement to being self-

[6] For example, with a progressive tax structure, marginal tax rates automatically fall during a recession. The correlation between the level of tax rates and *growth* is less clear, however.

[7] See, for example, Carroll et al., (1998, 2000), Gordon (1998), Gentry and Hubbard (2000), and Cullen and Gordon (2002).

employed when the effective tax rate on business income is less than the tax rate on wage and salary income. This would occur to the extent that the corporate tax rate is below marginal personal tax rates.

Risk-taking per se is affected by the tax structure to the extent that profits and losses are taxed at different marginal tax rates.[8] If entrepreneurs can shift the organizational form of their business ex post, or at least shift income and losses flexibly between the corporate and personal tax base, then any difference between personal and corporate tax rates generates a subsidy to risk-taking. In particular, when personal tax rates are above the corporate rate, entrepreneurs should report any losses as noncorporate losses, and any profits as corporate income, thereby facing a subsidy to risk-taking to the extent that the corporate tax rate is below personal tax rates.[9]

As emphasized by Gentry and Hubbard (2000), to the extent that businesses always remain noncorporate, then risk-taking is discouraged to the extent that the personal tax schedule is progressive. Here, losses push the entrepreneur into a low tax bracket, saving little in taxes, while profits push the entrepreneur into a high marginal tax bracket. Finally, if nontax factors imply that the firm should always be corporate, then no-loss-offset provisions in the corporate tax become key. Given no-loss-offset, the higher the corporate tax rate the greater the net discouragement to risk-taking.

Another tax advantage of entrepreneurial activity is that tax evasion is much easier for the self-employed than for employees. This provides a further reason why high personal tax rates, affecting employees much more than the self-employed, can encourage entrepreneurial activity.

When entrepreneurs are risk averse, taxes also provide risk-sharing with the government. If the financial markets are not effective at sharing risks efficiently, at least for small firms, then entrepreneurial activity can be an increasing function of overall effective tax rates.

No mention has been made of value-added taxes so far. In theory, a VAT is a proportional tax on net output, so should be neutral by the above arguments. However, in practice a firm with negative value-added, due to an unsuccessful project, will commonly have a hard time receiving the implied tax rebates from the government. To the extent there is no-loss-offset in practice under the VAT, so that favorable outcomes are taxed while unfavorable outcomes do not save on taxes, a higher VAT rate should also discourage risk-taking.

2.4. Other government policies affecting rates of entry

Many other government policies can affect the rate of entrepreneurial activity. To isolate the effects of taxes per se, we will want to control for other relevant policies.

[8] If the tax rates on profits and losses are the same, then the tax structure is simply equivalent to having more outside shareholders.

[9] If the corporate tax rate were above personal tax rates, then losses should be taken under the corporate tax. But if the firm faces binding no-loss-offset provisions, then its marginal tax rate is zero, eliminating any potential subsidy to risk-taking.

Some direct policies, such as R&D subsidies, may be effective at stimulating innovation. However, we have not been able to find any information on the size of such R&D subsidies for our sample.

In many countries corruption, i.e. the need to pay endless bribes to government officials to obtain necessary licenses, discourages small business activity. Governments can also use tariff and nontariff barriers to protect favored existing industries, thereby putting other industries at a competitive disadvantage. Governments on occasion use inflation as an important source of finance, raising the costs to new entrants that rely more heavily on cash transactions, while leaving relatively unaffected the costs faced by large existing firms that normally rely more heavily on financial intermediaries.

The greater these barriers to entry, the lower the amount of entrepreneurial activity and presumably the slower the growth rate. In an attempt to capture the effects of taxes per se, we include some available controls for these other policies in the empirical work.

2.5. Endogenous government policies

One unavoidable caveat in any study looking at the effects of government policies on growth is the possibility of incidental or reverse causation. Certainly, tax structures in richer countries differ from those in poorer countries, with more reliance on the personal income tax and a tendency to higher tax rates in richer countries.[10]

During periods of high growth, there will be heavy demand for new infrastructure investment, suggesting high tax rates generally to finance these investments. Certainly, there is no clear case dismissing a possible effect from high growth rates to tax rates, and government policies more generally.

The approach we use to try to deal with the possible endogeneity of the personal and corporate tax rates is to use as instruments the weighted average personal and corporate tax rates in other countries, weighting by the inverse of the distance between the two countries.[11] The correlation in the tax rates in nearby countries is remarkably high in the data.[12] Yet the growth rate in a country that is small relative to the regional and world economy should have virtually no effect on the tax rates in these other countries, making the weighted average tax rates elsewhere a good instrument for the local tax rates.

3. Empirical strategy

Our main empirical strategy will then be to look for effects of the above tax effects on rates of growth of per capita GDP, using a cross-sectional data set of countries.

[10] This implies a correlation between tax rates and the level of income, though not necessarily with growth rates.

[11] Distance measures between two countries come from CEPII, Centre D'Etudes Prospectives Et D'Informations Internationales (http://www.cepii.fr/). Geodesic distances are calculated following the great circle formula, which uses latitudes and longitudes of the most important cities/agglomerations in terms of population.

[12] The correlation between the corporate tax rate and the weighted average corporate tax rate in other countries is 0.645, while the equivalent correlation for personal tax rates is 7.

In particular, assume for simplicity that the production function for domestic output can be approximated by a Cobb–Douglas function, so that per capita output satisfies $f_t(k_t)=a_t k_t^{\alpha} h_t^{\beta} e^{\eta}$, where k denotes the capital/labor ratio, and h the average human capital per worker. Then, the growth rate for the economy's output satisfies:

$$\dot{f}/f = \dot{a} + \alpha(\dot{k}/k) + \beta(\dot{h}/h) + \dot{\eta}. \tag{1}$$

Any productivity growth brought about by entrepreneurial activity should show up in the first term, $\dot{a}$, so that tax effects on entrepreneurial activity show up here.

The second and third terms in Eq. (1) capture any changes in the capital/labor ratio and in education per worker. These can in part be due to recent changes in the tax law. We will control directly for the level of education of new entrants to the labor force.[13] Controlling for education, any impact of the tax law captures effects other than impacts on education.

The final term captures in part any transitory cyclical changes in output, which in principle might be correlated with tax rates. We will be looking at growth rates over a longer time period, so that any remaining net cyclical effects should be small.

The basic specification we then start with is as follows:

$$GR_i = \beta_0 + \beta_1 \tau_i + \beta_2 t_i + \beta_3 s_i + X_\gamma + e_i, \tag{2}$$

where GR_i is an annual growth rate of GDP per capita from 1970 to 1997, τ_i is the top statutory corporate tax rate in the 1980s, t_i is a representative personal income tax rate, s_i is the consumption tax rate, and X is a control vector, including the log of GDP per capita in 1970, government expenditures over GDP in 1970,[14] the primary school enrollment rate in 1970,[15] a measure of trade openness, the average tariff rate, an index for corruption and the quality of the bureaucracy during 1985–1989, the average inflation rate from 1970 to 1997, and the annual rate of population growth from 1970 to 1997.

Our estimating equation minus the tax variables is based on the specification used in the two most influential papers in the growth literature: Mankiw et al. (1992) and Barro (1996). Mankiw et al. (1992) regressed growth rates on initial GDP per capita and school enrollment rates, and Barro (1996) added government expenditure, political stability, and price distortions. Education has been expected to be the most influential factor affecting economic growth, even though there has been debate on the best measure of education (e.g. Benhabib and Spiegel, 1994; Pitchett, 1996). Trade openness has been added as an important factor affecting economic growth (e.g. Frankel and Romer, 1999; Dollar and Kraay, 2003), though Rodrik and Rodriguez (1999) presented a skeptical view on the existing evidence on the effects of trade openness on growth. The effect of institutions and corruption on economic growth has become an active research area since the late 1990s (e.g. Knack and Keefer, 1995; Mauro, 1995), and recently Hall and Jones (1999) and

[13] Formally, the change in average education depends on the education of new entrants compared with that of retiring workers. We have no data on the latter, so rely on initial GDP per capita as a control.

[14] We also tried including the ratio of total tax revenue to GDP (e.g. Ram, 1986; Engen and Skinner, 1992).

[15] We tried including as well the secondary and tertiary enrollment rates in 1970, but their coefficients were consistently virtually zero. The primary school enrollment rate for males also did less well than the overall primary school enrollment rate.

Acemoglu et al. (2001) address endogeneity by utilizing exogenous factors in institutions from colonial origin and settler mortality, respectively.

We also experiment with including the ratio $t_i^{\max}/\bar{t}_i$, where $\bar{t}_i$ is the average personal tax rate and $t_i^{\max}$ is the top marginal tax rate. If taxes are enforced, this variable provides some information about the progressivity of the personal income tax. However, if tax enforcement is weak, it also captures the degree of tax evasion. As a result, the forecasted sign of the coefficient is ambiguous.

One issue is how to come up with an estimate of a "representative" personal income tax rate. There are four approaches we considered: (1) the top statutory personal tax rate; (2) estimated effective marginal tax rates from a regression of total tax revenue on GDP (Koester and Kormendi, 1989; Garrison and Lee, 1992; Padovano and Galli, 2001); (3) the effective average tax rate on labor income, comparing personal tax payments to observed labor income (Mendoza et al., 1994,1997); and (4) a weighted average statutory individual income tax rate (Easterly and Rebelo, 1993a,b).

None of these four measures is ideal. The top statutory tax rate, for example, may approximate well the tax rate faced by potential entrepreneurs, though will measure less well the incentives faced by the rest of the population. Koester and Kormendi (1989) attempt to measure the overall marginal tax rate on all activity that expands with GDP, which can be a poor measure of the marginal personal tax rates on labor income. Mendoza et al. (1994) measures at best an average tax rate on labor income, not a marginal rate, yet incentives depend on marginal rates. Easterly and Rebelo (1993b) construct a weighted average of statutory personal income tax rates, taking into account the full schedule of tax rates and the distribution of incomes. While in principle this is a natural measure, evasion rates in many developing economies are so high that the statutory rates in fact may have little relation with effective tax rates.

The top marginal tax rate and the Easterly–Rebelo estimates of average marginal tax rates are conceptually the most appealing measures of these four. Given our focus on the possible role of entrepreneurial activity in economic growth, the top marginal tax rate has particular appeal. It is also available for a larger sample of countries. It will still be a noisy measure of the incentives created by the full personal tax schedule, and as mentioned above could in principle be endogenous. Instrumental variable procedures should help address both sources of potential bias. We used the weighted average of the top personal tax rates in other countries, weighting by the inverse of distance, as an added instrument.

4. Data

Data on statutory top corporate and individual income tax rates come from the World Tax Database from the Office of Tax Policy Research (OTPR) at the University of Michigan. The OTPR provides extensive tax data compiled from various sources, including the World Bank's World Development Indicator (WDI) and Price Waterhouse Cooper (PwC), *Corporate Taxes: Worldwide Summaries* and *Individual Income Taxes: Worldwide Summaries*. The OTPR data provide statutory tax rates only since 1980, which determined the beginning date in our estimation.

There exists large variation in statutory top corporate tax rates across countries, as seen in Table 1. Statutory top individual income tax rates also vary greatly, for example in 1985 from below 15% (Cote d'Ivoire and Switzerland) to above 70% (Belgium, Netherlands, Dominican Republic, Zambia, and Sweden).

Corporate tax rates also varied greatly over time. Average corporate tax rates dropped from 41.3% in the 1980s to 34.8% in the 1990s. Cross-country variation of corporate tax rates tends to persist over time: the correlation between corporate tax rates in the 1980s and those in the 1990s is 0.656 (p-value=0.000).

Data on statutory consumption (either GST or VAT) tax rates come from PricewaterCoopers (PwC), *Corporate Taxes 1999–2000, Worldwide Summaries*. For countries with missing values in the PwC's publication, we use the values in Ernst and Young's *Worldwide Corporate Tax Guide*. Since we have access only to recent issues of those publications, we are forced to use commodity tax rates in 1999. Statutory consumption tax rates vary from below 5% (Guyana, Hong Kong, Oman, United States, Iran, Singapore, and India) to 25% (Denmark, Hungary, and Sweden).

Data on average tariff rates in 1995 come from WDI, which reports average tariff rates calculated using UNCTAD's Trade Analysis Information System (TRAINS). Since

Table 1
Distribution of statutory top corporate tax rates in 1985, 70 countries

Corporate tax rates	Countries
Below 30% (4 countries)	19%: Hong Kong
	20%: Ecuador
	24%: Chile
	29%: Switzerland
30–34% (8 countries)	30%: Bolivia, El Salvador, Korea, Rep., Paraguay, Thailand, Uruguay
	33%: Argentina, Senegal
35–39% (7 countries)	35%: Botswana, Brazil, Indonesia, Philippines, Spain
	36%: Italy
	39%: Cameroon[a]
40–44% (17 countries)	40%: China, Colombia, Cote d'Ivoire, Denmark, Egypt, Arab Rep., Honduras, Israel, Malaysia, Nicaragua, Portugal, Singapore, Turkey[b]
	42%: Guatemala, Mexico, Finland
	43%: Japan, Netherlands
45–49% (16 countries)	45%: Belgium, Jamaica, Kenya, New Zealand, Nigeria, Sierra Leone, Trinidad and Tobago, United Kingdom, Zimbabwe[c]
	46%: Australia, Canada, Dominican Republic, United States
	48%: Morocco
	49%: Congo, Rep., Greece[a]
50–54% (12 countries)	50%: Congo, Dem. Rep., Costa Rica, France, Haiti, Ireland, Malawi, South Africa, Sri Lanka, Venezuela[d], Zambia[c]
	51%: Norway
	52%: Sweden
Above 55% (6 countries)	55%: Austria, Guyana, India, Pakistan, Peru[a]
	60%: Ghana[b]

[a] Tax rates in 1988.
[b] Tax rates in 1980.
[c] Tax rates in 1981.
[d] Tax rates in 1986.

the average tariff rates are available only for 20–30 countries each year in WDI, we implement two methods to increase the number of observations. First, we start with the rates in 1995 and expand to adjacent year to increase the number of observations. Since the tariff rates are available only for 41 countries even substituting the value in adjacent years, we use estimates for the tariff rates from Lee and Azfar (2001). Lee and Azfar generate estimates for the tariff rates from the regression of tariff rates on the ratio of tariff revenue to imports.

Data on GDP, school enrollment rates, inflation rates, and population come from WDI. GDP per capita in constant 1995 US$ is used in the calculation of the annual growth rate of GDP per capita. The (gross) school enrollment rate is defined as the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. For the enrollment rates, we focus on primary school enrollment rates in 1970. The measured inflation rate is the average inflation rate from 1970 to 1997.

The index for corruption and quality of bureaucrat (ICRG index) is an average of two ICRG indices, corruption in government and quality of the bureaucracy. Each index is on a scale from 0 to 6 and a higher number implies less corruption and better quality bureaucracy. The average of this index from 1985 through 1989, the earliest years available, is used in the growth regressions. In the sample, Bangladesh, Paraguay, Indonesia, Haiti, Congo, Dem. Rep., Guyana, and Bolivia received the lowest rating, while Finland, Switzerland, Denmark, New Zealand, Netherlands, Sweden, and Canada received the highest rating. The trade openness index is the fraction of years during 1970 to 1974

Table 2
Summary statistics for growth regressions

Variables (unit and sources)	*n*	Mean	S.D.	Min	Max
Top corporate tax rates, 1980–1989 (%, OTPR)	70	41.3	8.2	17.7	60
Top corporate tax rates, 1990–1997 (%, OTPR)	69	34.8	6.5	14	50
Top personal tax rates, 1980–1989 (%, OTPR)	66	52.0	14.9	0	79.5
Average overall tax rate, 1970–1979 (%, WDI)	66	18.4	8.7	0	42.4
Koester and Koremendi tax rates, 1970–1979 (%, authors' calculation using WDI)	63	21.4	10.0	6.6	51.7
Average tariff rates, 1995 (%, WDI, Lee and Azfar)	58	6.7	6.3	−5.8	29.1
Commodity tax rates, 1999 (%, PricewaterCoopers, Ernst and Young)	67	14.2	6.1	0	25
Growth rate of GDP per capita, 1970–1997 (annual %, WDI)	70	1.7	2.1	−4.2	6.9
GDP per capita, 1997 (1995 constant US$, WDI)	70	9809	12,290	113	44,300
GDP per capita, 1970 (1995 constant US$, WDI)	70	5489	7222	120	35,424
Primary school enrollment rates, 1970 (%, WDI)	70	90.4	22.4	34.8	122.8
Average trade openness, 1970–1974 (fraction, Sachs and Warner)	70	0.4	0.5	0	1
ICRG's corruption and bureaucrats' quality, 1985–1989 (0–6, ICRG)	70	3.5	1.5	0.6	6
Population growth rates, 1970–1997 (%, WDI)	70	1.8	1.0	0.2	3.7
Average inflation rates, 1970–1994 (%, WDI)	70	78	225	4	1231

that a country had open trade, and is constructed with data from Sachs and Warner (1995).[16]

Summary statistics for a 70-country sample are reported in Table 2.

5. Regression results

Table 3 focuses first on the role of the corporate tax rate. Column 1 shows that the growth rate of GDP per capita from 1970 to 1997 is negatively correlated with statutory top corporate tax rates. The coefficient implies that a 10% point decrease in corporate tax rates is associated with a 0.64% point increase in the annual growth rate of GDP per capita.

Column 2 reports regression result with the set of independent variables discussed in Section 3, which are variables found to be significant in many recent studies of economic growth. The coefficient on the corporate tax rate becomes slightly more negative. The other coefficients are consistent with prior results that countries growth faster when they have low initial income, more educated citizens, more open trade, less corrupt government, and lower inflation rates.

Column 3 shows that corporate tax rates remain significant when continent/group dummies are added.[17] These dummies mainly capture the pattern that African and Latin American countries grew less rapidly. Column 4 of Table 3 allows the tax coefficient to vary between OECD and non-OECD countries. The estimated tax coefficient ($-0.068+0.060=-0.008$) is near zero for OECD countries. However, the difference between the two coefficients is not statistically significant.[18]

Column 5 shows that the coefficient of the corporate tax rate remains significant and does not vary much when other tax variables are included in the regression. This regression also shows the robustness of our results to changes in the sample since we lose additional observations when other tax variables are added.[19] Other tax variables tested are the statutory top individual income tax rate, top/average personal tax rates (a measure of progressivity), average overall tax rates, the ratio of government expenditure to GDP, Koester and Kormendi's measure of the overall marginal tax rates, average tariff rates, and average commodity tax rates. None of the other tax variables are significant.

Columns 6 and 7 report instrumental variable results. In column 6, the weighted average of corporate tax rate, weighting by the reciprocal of distance between the two countries, is used as an instrument for the corporate tax rate. The estimated coefficient of

[16] Sachs and Warner consider a country open if: (i) non-tariff barriers cover less than 40% of the countrýs trade, (ii) the average tariff rate is less than 40%, (iii) the black market premium is less than 20% during the 1970s and 1980s, (iv) the country is not classified by Janos Kornai (1992) to be socialist, and (v) the government does not have a monopoly on major exports.

[17] The omitted category includes Caribbean, North African, and Middle Eastern countries not in the OECD.

[18] Similarly, Garrison and Lee (1992) find that the Koester–Kormendi effective tax rate is significant only among non-industrialized countries.

[19] We also tried adding these other tax variables one by one, to maximize the sample size in each case. In each case, the added tax variable had a statistically insignificant coefficient. The other coefficients were effectively unchanged.

Table 3
Baseline cross-sectional growth regression results, OLS and IV

Estimation method	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) IV	(7) IV
Corporate tax rates, 1980–1989	−0.064 (0.030)*	−0.069 (0.025)**	−0.057 (0.023)*	−0.068 (0.029)*	−0.073 (0.035)*	−0.109 (0.039)**	−0.084 (0.044)+
Log of GDP per capita, 1970		−1.216 (0.265)**	−0.867 (0.281)**	−1.091 (0.281)**	−0.998 (0.422)*	−1.269 (0.264)**	−1.444 (0.280)**
Primary school enrollment rate, 1970		0.036 (0.010)**	0.023 (0.009)*	0.032 (0.010)**	−0.005 (0.017)	0.036 (0.010)**	0.033 (0.010)**
Average trade openness, 1970–1974		1.285 (0.567)*	0.762 (0.581)	1.459 (0.610)*	2.162 (0.631)**	1.004 (0.603)	1.242 (0.609)*
Average ICRG index, 1985–1989		0.725 (0.204)**	0.671 (0.195)**	0.766 (0.205)**	0.163 (0.288)	0.748 (0.218)**	0.765 (0.218)**
Population growth rate, 1970–1997		−0.312 (0.295)	−0.031 (0.286)	−0.496 (0.314)	−0.117 (0.467)	−0.556 (0.298)+	−0.751 (0.307)*
Average inflation rate, 1970–1997		−0.003 (0.001)**	−0.003 (0.001)**	−0.003 (0.001)**	0.001 (0.005)	−0.003 (0.001)**	−0.003 (0.001)**
Continent dummy							
• Sub-Saharan Africa			−2.283 (0.741)**				
• OECD countries			−0.897 (0.896)				
• Latin America			−1.164 (0.673)+				
• Asia			0.698 (0.797)				
Dummy for OECD countries				−3.635 (2.689)			
OECD dummy×corporate tax rates				0.060 (0.063)			
Top personal tax rates, 1980–1989					0.012 (0.017)		−0.020 (0.020)
(Top/average personal tax rates), 1980–1989					0.000 (0.000)		
Average overall tax rate, 1970–1979					−0.021 (0.145)		
Government expenditure/ GDP, 1970–1979					0.030 (0.110)		
Koester and Koremendi tax rates, 1970–1979					0.020 (0.056)		
Average tariff rates, 1995					0.008 (0.043)		
Commodity tax rates, 1999					−0.038 (0.044)		
Observations	70	70	70	70	44	68	64
Adjusted *R*-squared	0.051	0.469	0.619	0.476	0.411	0.526	0.551

Dependent variable is the growth rate of GDP per capita from 1970 to 1997.
Standard errors in parentheses.
Constant term is included, but not reported.
* Significant at 5%.
** Significant at 1%.
+ Significant at 10%.

the corporate tax rate in the IV estimation is now about 60% larger in absolute value than in the OLS specification, and equally significant. Apparently, rapid growth induces a higher corporate tax rate, perhaps to pay for needed infrastructure investments, biasing upwards the OLS coefficient.

In column 7, the top personal tax rate is added to the specification, but treated as endogenous with the weighted average of the top personal tax rates in other countries, weighted by the inverse of distance, used as an added instrument. The estimated coefficient of the personal tax rate in the IV specification remains small, and all values within a 95% confidence interval are also small. The other coefficients are qualitatively unaffected.

These specifications all include education as a control, so that the tax coefficients omit any effects of the tax law on educational outcomes. When we drop education from the specification, so that the tax effects now include any impact of taxes on education, the tax coefficients are virtually unchanged, with a slightly more negative coefficient on the corporate tax rate.

We also reestimated the specification in column 2 for 1980–1997, and for 1990–1997, measuring the average corporate tax rate during the periods 1980–1989 and 1990–1997, respectively. The coefficient of corporate tax rates is somewhat smaller during 1980–1997 (-0.046 with standard error 0.028), and somewhat larger during 1990–97 (-0.102 with standard error 0.031).

Table 4 reports panel regression results, based on data for three 5-year periods and one 3-year period: 1980–1984, 1985–1989, 1990–1994, and 1995–1997. We regress the annualized growth rate of GDP per capita on the corporate tax rate in the initial year of each observation, and other control variables. In OLS regressions, the estimated coefficient of the tax rates is -0.058. Robustness to outliers is checked by using estimation methods less sensitive to outliers, robust regressions and median regressions. The estimated coefficient of the statutory corporate tax rate remains significant at the 10% level in both (columns 2 and 3). In fixed-effects estimation results (column 4), the estimated coefficient of the corporate tax rate is -0.082. IV results, still including fixed effects, are reported in column 5, and then in column 6 including the top personal tax rate. The coefficient of the corporate tax rate is now twice as large as in the OLS fixed-effects results, while the coefficient of the personal tax rate is virtually zero.

We now attempt to provide some indirect evidence on the mechanism by which the corporate tax rates affects economic growth. Based on the discussion in Section 2, a low corporate tax rate can generate both a higher rate of capital investment and more entrepreneurial activity, so greater learning. One way to distinguish between the two is by looking for effects of the corporate tax rate on personal tax payments. If a lower corporate tax rate generates added investment, then it should generate extra personal tax payments on the resulting income from capital. If instead, it generates added entrepreneurial activity, then it should reduce personal tax payments, due to the drop in wage and salary income, and due to the reporting instead of business losses but not large business profits under the personal tax.

We therefore examine how the corporate tax rate affected personal income tax payments in a panel data set with 87 countries covering the years 1972–1998, using as controls the personal tax rate, GDP per capita, and country dummies.

Table 4
Panel growth regression results

Estimation method	(1) OLS	(2) Robust	(3) Median	(4) Fixed Effect	(5) Country dummies+IV	(6) Country dummies+IV
Corporate tax rates[a]	−0.058	−0.047	−0.047	−0.082	−0.171	−0.182
	(0.019)**	(0.019)*	(0.027)+	(0.025)**	(0.034)**	(0.046)**
Personal tax rates[a]						0.001
						(0.026)
GDP per capita[a]	−1.078	−1.027	−1.126	−4.412	−4.321	−5.247
	(0.223)**	(0.216)**	(0.312)**	(0.985)**	(1.067)**	(1.282)**
Primary school enrollment[a]	0.026	0.028	0.025	0.025	0.017	0.031
	(0.011)*	(0.011)**	(0.016)	(0.020)	(0.020)	(0.023)
Average openness[b]	2.672	2.586	2.854	2.051	1.358	1.352
	(0.480)**	(0.465)**	(0.666)**	(0.675)**	(0.713)+	(0.772)+
Average ICRG index[b]	0.527	0.342	0.284	0.316	0.211	−0.115
	(0.201)**	(0.195)+	(0.280)	(0.477)	(0.523)	(0.586)
Population growth rates[b]	−0.730	−0.840	−1.021	−1.311	−1.086	−0.952
	(0.227)**	(0.220)**	(0.320)**	(0.434)**	(0.460)*	(0.523)+
Average inflation rates[b]	−0.002	−0.002	−0.002	−0.001	−0.001	−0.001
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Constant	7.719	7.579	8.821	−−	−−	−−
	(2.030)**	(1.967)**	(2.844)**			
Observations	270	270	270	270	245	221
Number of countries	77	77	77	77	68	67
R-squared	0.323	0.326		0.293	0.651	0.665

Dependent variable is growth rate of GDP per capita for 5-year periods.
Standard errors in parentheses.
There are five periods in the panel: 1980–1984, 1985–1989, 1990–1994, and 1995–1997.
[a] These variables take values at the initial year.
[b] These variables are growth rates or average values calculated for the corresponding period.
* Significant at 5%.
** Significant at 1%.
+ Significant at 10%.

Summary statistics are reported in Table 5. The resulting fixed effect estimates are as follows:[20]

$$(\text{Personal tax revenue}/\text{GDP}) = \underset{(2.175)^{**}}{-10.424} + \underset{(0.241)^{**}}{1.615} \times \log(\text{GDP per capita}) + \underset{(0.005)^{**}}{0.023} \times \tau + \underset{(0.003)^{*}}{0.008} \times t$$

These estimates show that the corporate tax rate is associated with an increase in personal income tax revenue, providing evidence that individuals report more wage and salary

[20] The R-squared is 0.064, the number of observation is 938, and number of countries is 87. Standard errors are in parentheses.

Table 5
Summary statistics for tax revenue regressions, n=938, number of countries=87

Variables	Unit and Sources	Mean	S.D.	Min	Max
Top corporate income tax rate	%, OTPR	48.31	16.84	0	93
Top individual income tax rate	%, OTPR	39.04	8.17	15	75
Personal income tax revenue/GDP	%, OTPR, IMF	4.70	4.16	0	20.86
GDP per capita	1995 constant US$, WDI	11,038	11,447	217	45,888

income when the corporate tax rate is higher. One explanation is that fewer people go into business for themselves when the corporate tax rate is higher, for any given personal tax rate.

6. Conclusions

This paper finds that the corporate tax rate is significantly negatively correlated with economic growth in a cross-section data set of 70 countries during 1970–1997, controlling for many other determinants/covariates of economic growth. We also find that other tax variables, including the average tax rate on labor income and Koester and Kormendi's effective overall marginal tax rates, are not significantly associated with economic growth rates. The estimates suggest that cutting the corporate tax rate by 10 percentage points can increase the annual growth rate by around 1.1%. In fixed-effects estimates using a panel data set constructed for the same overall time period, estimated effects are larger, with the same tax change implying an increase in the annual growth rate of around 1.8%.

An open question is the reason for this negative effect of the corporate tax rate on growth. We report evidence that lower corporate tax rates lead to lower *personal* tax revenue, a result consistent with a lower corporate tax rate encouraging more entrepreneurial activity. However, the aggregate information reported here is insufficient to draw a definitive conclusion about the precise source of the links between tax rates and growth.

These results certainly suggest that the growth effects of tax reforms, as well as the more standard efficiency and equity effects in a static context, merit serious consideration. These growth effects plausibly reflect a correction for the positive externalities arising from innovative activity, externalities neglected in standard tax analysis.

Acknowledgement

We would like to thank Jim Poterba, the two referees, as well as seminar participants at the Hanyang/Konkuk/Sejong Joint Seminar on Economics and KERI (Korea Economic Research Institute), for comments on a previous draft. This work was supported by the research fund of Hanyang University (HY-2003-1).

References

Acemoglu, Daron, Johnson, Simon, Robinson, James A., 2001. The colonial origins of comparative development: an empirical investigation. American Economic Review 91 (5), 1369–1401.

Barro, Robert J., 1996. Determinants of Economic Growth: A Cross Country Empirical Study. NBER, Cambridge.

Benhabib, Jess, Spiegel, Mark M., 1994. The role of human capital in economic development: evidence from aggregate cross country data. Journal of Monetary Economics 34 (2), 143–173.

Robert Carroll, et al. "Income Taxes and Entrepreneurs' Use of Labor," N.B.E.R. Working Paper No. 6578, 1998.

Carroll, Robert, et al. "Personal Income Taxes and the Growth of Small Firms," N.B.E.R. Working Paper No. 7980, 2000.

Cullen, Julie Berry, Roger H. Gordon. "Taxes and Entrepreneurial Activity: Theory and Evidence for the U.S.," NBER Working Paper No. 9015, 2002.

de Long, J. Bradford, Summers, Lawrence H., 1991. Equipment investment and economic growth. Quarterly Journal of Economics 106, 445–502.

Dollar, David, Kraay, Aart, 2003. Institutions, trade, and growth. Journal of Monetary Economics 50, 133–162.

Easterly, William, Rebelo, Sergio, 1993. Fiscal policy and economic growth. Journal of Monetary Economics 32, 417–458.

Easterly, William, Rebelo, Sergio, 1993. Marginal income tax rates and economic growth in developing countries. European Economic Review 37, 409–417.

Engen, Eric M., Jonathan Skinner. "Fiscal Policy and Economic Growth," NBER Working Paper No 4223, 1992.

Feldstein, Martin S., 2002. The transformation of public economics research: 1970–2000. Journal of Public Economics 86, 319–326.

Frankel, J.A., Romer, D., 1999. Does trade cause growth? The American Economic Review 89 (3), 379–399.

Garrison, Charles B., Lee, Feng Yao, 1992. Taxation, aggregate activity and economic growth: further cross country evidence on some supply side hypotheses. Economic Inquiry 30, 172–176 (January).

Gentry, William M., Hubbard, R. Glenn, 2000. Tax Policy and Entry into Entrepreneurship, mimeo.

Gordon, Roger, 1998. Can High Personal Tax Rates Encourage Entrepreneurial Activity? IMF Staff Papers, pp. 49–80. March.

Hall, Bronwyn H., 1995. The private and social returns to research and development. In: Smith, Bruce L.R., Barfield, Claude E. (Eds.), Technology, R&D, and the Economy. The Brookings Institution, Washington, DC, pp. 140–883.

Hall, Robert E., Jorgenson, Dale W., 1967. Tax policy and investment behavior. American Economic Review 57, 391–414 (June).

Hall, Robert E., Jones, Charles I., 1999. Why do some countries produce so much more output per worker than others? Quarterly Journal of Economics 114 (1), 83–116.

Heckman, James, et al., 1998. Tax policy and human capital formation. American Economic Review 88, 293–297.

IMF, Government Financial Statistics.

Knack, Stephen, Keefer, Philip, 1995. Institutions and economic performance: cross country tests using alternative institutional measures. Economics and Politics 7 (3), 207–227.

Koester, Reinhard B., Kormendi, Roger C., 1989. Taxation, aggregate activity and economic growth: cross country evidence on some supply side hypotheses. Economic Inquiry 37, 367–386 (July).

Kornai, Janos, 1992. The Socialist System: The Political Economy of Communism, Princeton. Princeton University Press, New Jersey.

Lee, Young, Azfar, Omar, 2001. Does Corruption Delay Trade Reform? Mimeo.

Lucas, Robert E., 1988. On the mechanics of economic development. Journal of Monetary Economics 22, 3–42.

Mankiw, N. Gregory, David, Romer, Weil, David N., 1992. Contribution to the empirics of economic growth. Quarterly Journal of Economics 107 (2), 407–437.

Mauro, Paolo, 1995. Corruption and growth. Quarterly Journal of Economics 110 (3), 681–712.

Mendoza, Enrique G., Assaf, Razin, Tesar, Linda L., 1994. Effective tax rates in macroeconomics: cross country estimate of tax rates on factor incomes and consumption. Journal of Monetary Economics 34, 297–323.

Mendoza, Enrique G., Gian, Maria Milesi Ferretti, Asea, Patrick, 1997. On the ineffectiveness of tax policy in altering long run growth: Harberger's superneutrality conjecture. Journal of Public Economics 66, 99–126.

Moretti, Enrico. "Estimating the Social Return to Higher Education: Evidence from Longitudinal and Repeated Cross Sectional Data," Journal of Econometrics, in press.

Padovano, Fabio, Galli, Emma, 2001. Tax rates and economic growth in the OECD countries (1950–1990). Economic Inquiry 39, 44–57 (January).

Pitchett, Lant. "Where Has All the Education Gone?" World Bank Policy Research Working Paper #1581, 1996.
Ram, Rati, 1986. Government size and economic growth: a new framework and some evidence from cross section and time series data. American Economic Review 76, 191–203.
Rodrik, Dani and Rodriguez, F. "Trade Policy and Economic Growth: A Sceptic's Guide to the Cross National Evidence," Centre for Economic Policy Research Discussion Paper: 2143, May 1999.
Sachs, Jeffrey, Warner, Andrew, 1995. Economic Reform and the Process of Global Integration. Brookings Papers on Economic Activity.
Schumpeter, Joseph, 1942. Capitalism, Socialism, and Democracy. Harper, New York.
Solow, Robert M., 1970. Growth Theory: An Exposition. Oxford University Press, New York.
Trostel, Philip A., 1993. The effect of taxation on human capital. Journal of Political Economy 101, 327–350.
World Bank, World Development Indicators.