Taxation and Economic Growth:

The Case of Taiwan

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ABSTRACT. The effects of various *tax policies* on *economic growth* are reexamined on the basis of the recently developed endogenous *growth theory*. The assertion of *Henry George* that the structure of taxation is more important than the level of *taxation* in explaining economic growth is elaborated and verified. Annual data for *Taiwan* from 1954 to 1986 shows that the aggregate tax rate does not have significant effect on the long-run growth rates of private output, *consumption* and *production* factor inputs. This result is due to the positive effect of consumption taxation offsetting the negative effect of factor taxation on economic growth.

I

Introduction

THIS PAPER reexamines the effect of various tax policies on economic growth based upon the recently developed endogenous growth theory. Employing data for Taiwan covering the period from 1954 to 1986, we find that the structure of taxation is more important than the level of taxation in explaining economic growth. This corroborates Henry George's (1879) assertion.

Recent empirical studies on taxation and economic growth, based upon the theory of supply-side economics, have generated important policy implications. Marsden (1983) performed a cross-country analysis and found that a higher (aggregate) tax rate led to slower economic growth. The same result was obtained by Reynolds (1985) using marginal tax rates and by Skinner (1987) using personal and corporate income tax rates. However, in a recent study, Koester and Kormendi (1989) concluded that the aforementioned negative causation from tax rates to the economic growth rate disappeared once the level of per capita income is introduced into the conventional regressions.[1] A general problem associated with cross-country studies is that the estimated regression may indeed be spurious if country-specific characteristics are not included in the model. Within the endogenous growth framework, the economic growth

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rate depends crucially on the initial human and nonhuman capital stock, and the infrastructure of the government, as well as on the industry and trade structures.[2] These country-specific determinants of economic growth are important but have not been taken into account in the above cross-country studies.

This paper investigates the issue of taxation and economic growth by performing a time-series analysis for the case of Taiwan to avoid the above-mentioned problems associated with cross-country studies. It is appropriate to select this export-oriented, newly industrialized country because (i) Taiwan has a sustained income growth consistent with prediction of the endogenous growth theory; (ii) tax reform has been one of the central issues of Taiwan's economic development since the early 1960s; and, (iii) since personal interest and dividend incomes are essentially tax-exempt, it is easier to separate the capital tax from the wage tax.

Our analysis also differs from previous work in several other aspects. First, the empirical model is based upon a recently developed theory of *endogenous* growth (*cf.* Lucas 1988) in which both physical and human capital are endogenously accumulated. Since the evolution of human capital in Taiwan plays an essential role in its economic development, the present paper adopts a human capital embodied effective labor index in lieu of traditionally measured raw labor, such as number of employees or manhours employed. Second, we study not only the aggregate tax rate (which is defined as the ratio of real total tax revenues to real private income) but rates of individual taxes of different types (consumption, capital, and wage taxes). Third, we investigate the effect of taxation on the growth rate of real *per capita private GDP* (instead of real GDP) in order to detrend the population growth, as well as to remove the direct effect of government spending on aggregate demand.[3] Finally, the effect of taxation on the growth rates of consumption, capital and effective labor (in addition to output) is examined.

The main findings of the paper are as follows. The aggregate tax rate has essentially no effect on economic growth, which contrasts with previous work in which a higher aggregate tax was found to suppress the rate of real income growth. Rather, focusing on the main components of taxes, consumption and factor tax rates have statistically significant impacts on the long-run growth rates of macroeconomic aggregates. To be specific, the effect of factor taxation (especially, capital income taxation) is to suppress economic growth due to the creation of (both atemporal and intertemporal) distortion in resource reallocation. A higher consumption tax rate, on the other hand, may enhance economic growth through the betterment of domestic financial status in an economy with an efficiently operated government sector. As a matter of fact, the negative effect

of factor taxation is offset by the positive effect of consumption taxation and hence, the overall effect of the aggregate tax rate becomes insignificant.

The remainder of the paper is organized as follows. Section II describes the data and provides a brief historical review for Taiwan's macroeconomic performance and tax system. Section III presents a dynamic general equilibrium model of taxation that captures the main features of the economic development of Taiwan. A preliminary analysis on aggregate and individual tax rates of different types is presented in section IV. Section V investigates the effect of the aggregate tax rate on macro aggregates, while section VI examines the impacts of consumption and factor taxation on economic growth. Section VII concludes the paper.

II

Data and Historical Review

THE EMPIRICAL STUDY is conducted using the annual data for Taiwan from 1954 to 1986 (see the Appendix).[4] To account for potential output growth, we follow Denison (1962) and examine the long-run trend of the two major production factors, namely, per capita real gross capital stock owned by both private and public enterprises and the employment rate. These two factor inputs grew at very different rates (7.92% versus 0.77%), contrary to traditional beliefs.[5] It seems natural to regard this "unbalanced growth" as a result of ignoring the improvement of labor skill over time. Because of lack of a precise measure of the labor skill level, we compute an index of higher educated population and refer to it as a labor skill index.[6] This labor skill index grew at 6.24%; hence, the growth rate of effective labor (*i.e.,* the employment rate added to the labor skill index) became 7.01% (*i.e.,* 0.77% plus 6.24%). This is very close to the growth rate of capital and consistent with the prediction of endogenous growth models.

Over the sample period, government budget was virtually balanced and tax revenue was always the largest component of total government revenues (usually more than 60%).[7] Consumption taxes (including commodity tax and customs duties), the capital income tax (*i.e.,* corporate or business income tax) and the labor income tax (*i.e.,* personal income tax) were the main sources of tax revenues.[8] From 1955 to 1986, the proportion of tax revenues from consumption, capital, and labor taxes accounted for 42.1%, 8.2% and 15.4% respectively, which sum up to more than 65% of total revenues.[9] During the same period, the average aggregate tax rate (which is defined as the ratio of real total tax revenues to real private income before taxes) was around 27.0%. Since real total tax revenues grew at 5.45% which was less than the growth rate of real private income (6.69%),

the (average) aggregate tax rate thus decreased by 1.24% annually. For the major components of taxes, the average tax rates of consumption, capital and labor were about 12.2%, 13.3% and 3.9%, respectively. The labor tax rate increased by 2.00% annually, while the growth rates of consumption and capital taxes were not statistically significantly different from zero (see Figure 1).[10] The downward trend of the aggregate tax rate was due mainly to a reduction in the rates of amusement, feast, household, salt, slaughter, and stamp taxes. The increase in the labor income tax rate was a result of the tax reform in the 1960s.[11]

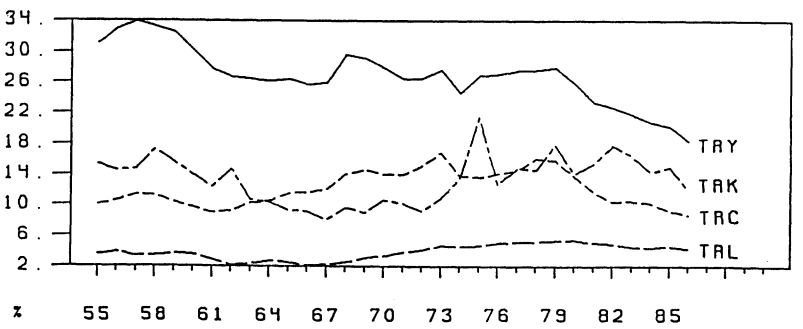
III

Theoretical Framework

FROM SECTION II we learn that (i) Taiwan's government spending was mainly tax financed (with major tax bases being consumption, capital income, and wages); and, (ii) human capital evolution played a key role in Taiwan's economic development. Thus, in studying the issue of tax structure, attention is restricted to examining the effect of consumption and factor taxation on macroeconomic aggregates (including private output, private consumption, and two major production inputs–physical capital and effective labor). To capture the main feature of Taiwan's development, it is postulated that the engine of growth is the endogenous accumulation of human capital, following seminal work of Lucas (1988, 1990).

Let k, n, and c denote (per capita) physical capital, (per capita) effective labor, (per capita) effective consumption, respectively. Effective labor is mea-

FIGURE 1
COMPUTED AVERAGE TAX RATES
(1955-86)



NOTE: Average long-run growth rates of TRY, TRC, TRK, and TRL are -1.24, 0.45, 0.49 and 2.00, respectively.

sured by $n = hl$, where h and l represent the human capital skill level and the fraction of time allocated to work, respectively (*cf.* Lucas 1988). Denote s as the fraction of time devoted to accumulating human capital and then leisure time can be measured by $x = 1 - l - s$. For simplicity, government is here assumed to be nonproductive, that is, (per capita) government expenditure, g, does not enter utility or production function. To finance this exogenous, nonproductive government expenditure, the government can choose to impose three different types of taxes: a consumption tax, a capital income tax, and a labor income tax. Taking consumption as the numeraire (*i.e.,* normalizing the price of consumption as unity), we can specify the (per capita) real tax collection as

$$T(t) = \tau_c c(t) + \tau_k r(t) k(t) + \tau_n w(t) n(t), \qquad [1]$$

where τ_c, τ_k, and τ_n denote respectively consumption, capital and labor tax rates, r measures the real rate of return on capital, and w represents the real wage rate.

The representative agent's lifetime utility can be written as

$$U = \int_0^\infty u(c(t), x(t)) e^{-\rho t} dt, \qquad [2]$$

where ρ denotes the constant rate of time preferences, and the instantaneous utility function, u, is homothetic and iso-elastic: $u(c, x) = (cv(x))^{1-\alpha}/(1-\alpha)$, with $\alpha > 0$, $v_x > 0$, and $v_{xx} < 0$. The (per capita) production technology takes a Cobb-Douglas form

$$y(t) = F(k(t), h(t) l(t)) = k(t)^\beta (h(t) l(t))^{1-\beta}, \qquad [3]$$

where β falls between zero and one, measuring the capital income share.

Therefore, our representative agent's optimization problem is to maximize his/her lifetime utility subject to

$$c(t) + \dot{k}(t) = F(k(t), h(t) l(t)) - T(t) \qquad [4]$$

$$\dot{h}(t) = h(t) G(s(t)), \qquad [5]$$

where $G_s > 0$. Equation [4] is a periodic budget constraint, while equation [5] specifies the evolution of human capital, governed by the endogenous time input, s. To close the model, we simply assume that the government budget is balanced periodically:

$$g(t) = T(t). \qquad [6]$$

In equilibrium, both production factors will receive their marginal products, that is, $r = F_k$ and $w = F_n$. To solve for a balanced-growth equilibrium, one may follow the technique developed by Lucas (1990).[12] Along a balanced-growth path, this produces

$$(1 - \tau_k) F_k = \rho + \alpha\theta \qquad [7]$$

$$u_x(t)/u_c(t) = (1 - \tau_n) h(t) F_n(t)/(1 - \tau_c) \qquad [8]$$

$$(1 - \tau_n) h(t) F_n(t)/(1 - \tau_c) = G_s(t) \int_t^{\infty} [(1 - \tau_n) h(\delta) l(\delta) F_n(\delta)/(1 - \tau_c)] e^{-\int_t^{\delta} (1-\tau_k) F_k(\eta)\, d\eta}\, d\delta, \qquad [9]$$

where $\theta = \dot{c}/c$, representing the balanced growth rate of consumption. The Keynes-Ramsey rule equation, [7], determines the equilibrium accumulation of physical capital. The atemporal no-arbitrage condition, [8], equates marginal benefit of leisure (in units of consumption utils) with its marginal cost. The labor-use efficiency condition, [9], makes the value of labor time devoted to production be equal, on the margin, to the value of allocating that unit of time to human capital accumulation.

From these equations, we can learn that both consumption and labor taxation will create a negative wealth effect through [9]. Nevertheless, within our theoretical framework, such effects are expected to be marginal because both tax rates appear on both sides of this efficiency condition and none of them can affect the engine of growth—human capital evolution. This is clear from the first-order conditions [7]–[9] since both τ_c and τ_n do not affect the economic growth rate, θ, directly. Different from a consumption tax, a tax on labor creates additional atemporal distortion via [8], although this atemporal adverse effect diminishes in the long run given the fact that time endowment is constant and hence leisure cannot vary along a balanced growth path. The most "harmful" tax is one imposed on physical capital, which, from [7], alters its marginal product, F_k, and the economic growth rate, θ. As a consequence, such a tax creates a serious intertemporal distortion and affects the human capital accumulation process via the discount rate, $(1 - \tau_k) F_k$.

In summary, consumption taxation is the least distortionary, and capital taxation generates the highest welfare cost. It should be noted however, that the government sector may contribute to economic growth through its public-good service and its productive impact on the formation of capital (*cf.* Barro 1990). Since taxing consumption does not create serious distortion, one may find a positive impact of a consumption tax on economic growth if the government is sufficiently productive.

IV

Preliminary Analysis on Tax Rates

A PRELIMINARY ANALYSIS on aggregate and individual tax rates and an examination of the possible differences between average and marginal tax rates are presented in this section.

Let *TREVY* denote (per capita real) aggregate tax revenue, and *TREVC*, *TREVK*, and *TREVL* denote (per capita real) revenues from taxing consumption, capital income, and labor income, respectively. *TBASEY* indicates aggregate tax base, measured by (per capita real) private *GDP*. Bases for consumption, capital, and labor taxes, denoted respectively by *TBASEC*, *TBASEK*, and *TBASEL*, are measured by (per capita real) private consumption, and capital and wage income, respectively. We now regress tax revenues of tax X (*TREVX*) on the correspondent tax bases (*TBASEX*):

$$TREVX_t = a_0 + a_1 * TBASEX_t, \qquad [10]$$

where $X = Y, C, K, L$, in turn denoting output, consumption, capital and labor. When the intercept (a_0) is not significantly different from zero, the marginal tax rate (a_1) is essentially the same as the average tax rate. The results are summarized in Table 1.

For the consumption and capital taxes, marginal rates are identical to the average rates. The marginal aggregate tax rate is smaller than its average rate,

TABLE 1
AVERAGE VERSUS MARGINAL TAX RATES

DEP VAR	--- INDEPENDENT VARIABLES ---					$\bar{R}^2$	F	D-W
	CONST	TBASEY	TBASEC	TBASEK	TBASEL			
TREVY	2.38 (4.53)*	0.1989 (19.7)*				.93	388.7	0.28+
TREVC	3.63 (0.92)		0.1124 (10.2)*			.78	104.6	0.24+
TREVK	-0.05 (-0.77)			0.1427 (15.7)*		.89	246.6	0.95+
TREVL	-0.41 (-4.86)*				0.0541 (28.6)*	.96	815.2	0.28+

NOTES: (a) DEP VAR = dependent variable; CONST = constant term; F = F-test statitic; D-W = Dubin-Watson statistic.
(b) T-test statistics are in parentheses.
(c) + indicates that first-order autocorrelation is present; * indicates that the estimated coefficient of the independent variable is significant at the 5% level.

while the marginal labor tax rate is larger than its average rate. The latter reflects the relative progressiveness of labor income taxation. The marginal aggregate tax rate appears to be 19.89%. The marginal rates of consumption, capital, and labor taxes are 11.24%, 14.27%, and 5.41%, respectively. The unusually low marginal labor tax rate is a consequence of tax exemption for school teachers and tax evasion in Taiwan.[13] Notice that these marginal tax rate measures are computed from the regression coefficient estimates (a_1). This provides only one data point and hence is not useful for a time-series study in which year-by-year observations are required. Later, in using "average" tax rate measures as proxies for the economic-theory addressed "marginal" tax rates, a possible measurement error regarding aggregate and labor tax rates might be present.

V

Aggregate Taxation and Economic Growth

THE EFFECTS of the aggregate tax rate, *TRY*, and its growth rate, *GRTRY*, on the growth rates of output, consumption, capital, and (effective) labor, denoted respectively by *GRY*, *GRC*, *GRK*, and *GRL*, will now be examined. (See section II for definition and measurement of these variables.)

To avoid possible specification errors, a preliminary univariate analysis reveals that (i) deviated from their mean values, growth rates of consumption and labor exhibit significant long-run upward trend (using a *t*-test); (ii) the capital growth rate has significant first-order autocorrelation (using the Durbin-ρ test); and, (iii) the private output growth rate is stationary with no serial correlation.[14] To properly study the nonspurious effect of tax policies on these macro aggregates, a time-trend variable, *TIME*, is incorporated into the regressions on consumption and labor growth rates, and a one-year lagged dependent variable, *LAGDEP*, into the regressions on the capital growth rate. Moreover, a possible long-run effect of the "imbalanced" export expansion in Taiwan, which cannot be easily addressed within the theoretical framework, requires examination. Specifically, it is postulated that the effect of a higher growth rate of the export-import ratio, denoted by *GREXR*, is to decrease imported investment goods (relatively) and hence to suppress capital accumulation.[15]

The following regression relation is examined:

$$\mathrm{GRX}_t = b_0 + b_1 * TRY_t + b_2 * GRTRY + b_t * M(i), \qquad [11]$$

where *GRX* denotes the growth rates of the macro variable *X*, with $X = Y, C, K, L$; *M* represents any other aforementioned variables, such as *TIME*, *LAGDEP*, and *GREXR*, whenever it is appropriate. The estimation results are presented in Table 2.

TABLE 2
EFFECTS OF AGGREGATE TAX RATE AND AGGREGATE TAX GROWTH RATE

DEP VAR	--- INDEPENDENT VARIABLES ---						$\bar{R}^2$	F	D-W
	CONST	LAGDEP	TIME	TRY	GRTRY	GREXR			
GRY	14.0			-0.2819	0.0713		-.02	0.8	1.52
	(2.21)*			(-1.22)	(0.46)				
GRC	11.8		0.0002	-0.2633	0.1954		.10	2.2	1.39
	(1.51)		(0.22)	(-1.10)	(2.02)#				
GRK	-0.31	0.8530		0.0615	-0.0681	-0.0865	.76	25.0	1.98
	(-0.11)	(8.94)*		(0.67)	(-1.15)	(-2.37)*			
GRL	10.4		0.0013	-0.2272	0.1025		-.00	1.0	1.72
	(0.59)		(0.64)	(-0.42)	(0.47)				

NOTES: (a) LAGDEP = one-year lagged dependent variable;
TIME = time trend variable (1955=1).
(b) # indicates that the estimated coefficient of the independent variable is significant at the 10% level.
(c) See also notes in Table 1.

An examination of the estimated coefficients (b_1 and b_2) for regressions on the growth rates of output, consumption, capital and effective labor shows that none of them are significant at the 5% significance level. These statistical results hold even if the aggregate tax rate and its growth rate are introduced into regression [11] one at a time. Among others, only the estimated coefficient of the growth rate of the aggregate tax rate is marginally significant at the 10% significance level in the regression of consumption growth. The insignificance of the impact of the aggregate tax rate contrasts with results in Marsden (1983) and Reynolds (1985) who found that a higher aggregate tax rate led to lower output growth using cross-country data. In addition, the discussion in section IV above reveals that the analysis using "average aggregate tax rate" in fact overstates the true effect of the "marginal rate." Thus this insignificance result should be stronger than it appears.

In Koester and Kormendi (1989), the absence of a negative relationship between tax rate and economic growth is due to the consideration of the endogeneity of the tax rate, as depending upon the level of per capita income. This is, however, not the case under the time-series setting here since the level of (the past) per capita (private) GDP is not incorporated into the above specified regressions. Thus it is necessary to study further why the traditional negative effect of aggregate taxation does not exist in Taiwan (or why the standard supply-side economics prediction is not applicable).

VI

Tax Structure and Economic Growth

THE EFFECT OF DIFFERENT TYPES OF TAXES, including consumption, capital and labor income taxes, on growth rates of the four macro aggregates now can be explored.

Denote *TRC*, *TRK*, and *TRL* as consumption, capital, and labor tax rates, respectively. Their corresponding growth rates are indicated respectively by *GRTRC*, *GRTRK*, and *GRTRL*. In analogy to [11], we can perform the following regression analysis to investigate individual tax rate effect:

$$GRX_t = b_0 + b_1 * TRZ_t + b_2 * GRTRZ + b_i * M(i), \qquad [12]$$

where $X = Y, C, K, L$; $Z = C, K, L$; and, M represents other variables discussed in section V above. The estimation results show that two-thirds of the regressions have significant explanatory power at the 5% significance level. Moreover, all regressions have Durbin-Watson statistics between 1.2 and 2.0, indicating there are no serious autocorrelations. Furthermore, the signs of the time trend, the lagged dependent variables and the growth rate of the export-import ratio are consistent with our prediction (see section III). Given our main focus that is on the macroeconomic effect of tax structure, we therefore report only the estimates of b_1 and b_2, accompanied by the F-statistic of each regression.

From Table 3, we summarize the implied tax effect on the growth rate of each macroeconomic variable as follows. First, either the consumption tax rate, or

TABLE 3
EFFECTS OF TAX RATES AND TAX GROWTH RATES: BY TYPES OF TAXES

DEP VAR	INDEPENDENT VARIABLES AND F-TEST STATISTICS								
	TRC	GRTRC	F	TRK	GRTRK	F	TRL	GRTRL	F
GRY	0.4396	0.1863	4.9	-0.5595	-0.0408	10.8	-0.0544	0.0767	0.6
	(1.44)	(2.19)*		(-2.39)*	(-1.05)		(-0.07)	(-1.07)	
GRC	0.2723	0.1520	6.2	-0.4980	0.0498	4.4	-1.0278	0.0610	2.1
	(1.42)	(2.73)*		(-3.20)*	(1.98)#		(-1.63)	(1.40)	
GRK	0.3967	-0.0169	29.2	-0.2293	-0.0082	37.7	-0.2296	0.0160	24.6
	(2.07)*	(-0.44)		(-2.70)*	(-0.51)		(-0.80)	(0.61)	
GRL	0.5762	0.1148	2.2	-0.8511	-0.0108	4.2	-2.2935	0.1616	2.9
	(1.20)	(0.82)		(-2.52)*	(-0.20)		(-1.74)#	(1.78)#	

NOTES: (a) Coefficient estimates of constant terms, lagged dependent variables, the time trend and the growth rate of the export to import ratio, as well as the Durbin-Watson statistics, are not of our main focus and hence not reported.
(b) See also notes in Tables 1 and 2.

its growth rate, generates a positive impact on the growth rates of private output, consumption and capital stock. The magnitude of such an effect ranges from 15% to 40%. Their impacts on the effective labor growth rate are insignificant at the 10% significance level. These results are, at first glance, contrary to the standard theory of commodity taxation. It is, however, interpretable given the specific characteristics of the macroeconomy of Taiwan. In the earlier stage of Taiwan's economic development, the underlying financial market was incomplete and most of the firms had little comparative advantage in exporting high value-added, nonagricultural goods. Although U.S. aid (about 1.5 billion U.S. dollars over the period from 1951 to 1968) made a significant contribution to the evolution of the Taiwan economy, most enterprises needed to accumulate sufficient amounts of internal funds to enhance production. At that time, higher customs duties seemed consistent with the import substitution strategy, and higher commodity taxes seemed to encourage more personal savings. These together led to a higher rate of accumulation of internal funds and thus enhanced investment and the physical capital stock. Moreover, the Taiwan government seems fairly efficient in producing public goods and public capital services, as compared with some inexperienced private firms. Such efficient government services may compensate for the marginal welfare cost associated with consumption taxation, consistent with our theoretical assertion.[10] As a consequence, we obtain a positive effect of the consumption tax rate on economic growth.

Second, the capital tax rate has a significantly negative effect on the growth rates of private output, consumption, and factor inputs. Quantitatively, a percentage point increase in the capital tax rate suppresses the growth rates of private output, consumption, capital, and effective labor by 0.56%, 0.50%, 0.23%, and 0.85%, respectively. The effect of the rate of change of the capital tax rate is, however, all insignificant at the 5% level. Notice that section IV shows the statistical equivalence between "average" and "marginal" tax rates of both consumption and capital income. Thus, the results obtained here are robust to both tax rate measures.

Third, both the labor tax rate and the rate of change of the labor tax rate have essentially no effect on economic growth at the 5% significance level. This contrasts with findings by Skinner (1987) in which the personal (or labor) income tax rate significantly suppresses the rate of GDP growth in African countries. The different findings may be due to efficient services of Taiwan's government which offsets the atemporal distortion of labor income distortion, or due to a potential measurement error as mentioned in section IV above. To be specific, the "average labor tax rate" used here is found to be significantly smaller than the true marginal labor tax rate, thus resulting in an underestimation of the labor-tax effect on the growth rates of macro aggregates. Nevertheless, at the

10% significance level, the effect of a percentage point increase in the labor tax rate is to reduce the effective labor growth rate by 2.29%, while a percentage point increase in the growth rate of the labor tax rate increases the rate of effective labor growth by 0.16%. In summary, labor income taxation only has marginally significant impact on the enhancement of effective labor but not on output growth. Generally speaking, the empirical evidence obtained here is consistent with our theoretical predictions.[17]

VII

Conclusions

THE FINDING that the aggregate tax rate has no significant impact on economic growth probably arises from the opposing effects of two major taxes: consumption taxes versus factor income taxes. There is, on the one hand, a conventional pervasive impact of factor taxation on the growth rates of economic aggregates. On the other hand, higher consumption taxes induce accumulation of internal funds which, through the enhancement of private savings, promotes economic growth in the earlier stage of economic development in an economy with an efficient government sector. The negative effect of factor taxes on economic growth is then compensated for by the positive effect of consumption taxes. As a matter of fact, this results in the insignificance of the overall impact of the aggregate tax rate on economic growth.

This conclusion emphasizes that an improper aggregation may lead us to an incorrect conclusion. The investigation of the aggregate tax effect without further study of tax structure may not help us to understand the real impacts of tax policy. Notably, the empirical evidence provided here is similar to the theoretical finding by Barro (1990) in which the negative effect of the aggregate income tax rate on economic growth is (at least partially) offset by the positive production effect of public services.

Along this line, it may be of interest to construct a generalized endogenous growth model for an export-oriented, small open economy considering (i) an incomplete financial market with liquidity constraints on consumption good purchases and capital good investment and (ii) an active government sector which produces consumption and capital services and finances its spending by consumption and factor income taxes. This can be regarded as an extension of the current framework by properly introducing international trade and capital flows into the model economy.[18]

Notes

1. Notice that an increase in per capita income would reduce the economic growth rate but increase the (average) aggregate tax rate. This results in a spurious negative effect of the aggregate

tax rate on economic growth in cross-country studies. See Koester and Kormendi (1989) for further elaboration.

2. For detail, the reader is referred to Lucas (1988) and Barro (1990).

3. To examine the relationship between government sector and private economy, one needs to test Wagner's law (*i.e.*, the enhancement of government size is a result from economic development), as well as to measure the productivity of government expenditure along the lines of Barro (1981) and Aschauer (1986), which require simultaneous equation estimation. Because of very limited annual data, this issue will not be addressed.

4. The sample period is chosen based on the availability of the data.

5. All growth rate measures are obtained by linearly regressing the logged values of these variables on a time trend variable. Their statistical significance is determined using a *t*-test. Such measures can be viewed as "long-run average" annual growth rates.

6. More specifically, we take the percentage of population at and over the age of six completing higher education (colleges and universities) and then convert this percentage into an index by setting its value in 1981 as unity. Notice that the percentage of population at and over the age of eighteen appears more appropriate but such data are not available. We also note that after converting the measure into an index, it is unit-free, satisfying our theoretical need.

7. Other major government revenues include surplus of public enterprises, gains from loans and financial assets, and tobacco and wine monopoly revenues (*i.e.*, profit from selling these sin goods by a government-owned monopoly corporation).

8. Without appropriate panel data, it is difficult to measure factor income taxes. Fortunately, personal interest/dividend income in Taiwan is virtually tax-free and so the personal income tax can be regarded as a tax on labor. Moreover, it is harmless to treat the corporate income tax as a tax on physical capital since most small businessmen, who create value-added mainly from labor input, are allowed to file the personal income tax only. Furthermore, the amount of custom duties imposed on intermediate investment goods seems negligible if the investment tax credit is considered as well. Thus, custom duties in our paper are viewed as taxes on consumption. Finally, since other taxes, such as amusement, feast, household, salt, slaughter, and stamp taxes, have been subject to many institutional changes over the past three decades, they are excluded from the measurement.

9. In the last decade, this increased to about 75%.

10. While the time trends of the aggregate and labor tax rates are statistically significant at the 5% level, the growth rate of taxes on consumption and capital is not.

11. For a comprehensive description of Taiwan's tax system and tax reform, the reader is referred to Chang (1988) and Riew (1988).

12. For detail, see sections 2–4 of Lucas (1990).

13. Issues on tax evasion cannot be elaborated because of the lack of data. Concerning the significance of the exemption for school teachers, one may learn from the fact that school teachers constitute about one-sixth of the Taiwanese population.

14. All growth rates here are stationary and thus the constant term of the growth rate regressions reported below can be used to measure the mean growth rates.

15. It is worth noting that more than 90% of imports in Taiwan are raw materials and investment goods which are mostly for production uses.

16. See also Summers (1981) in which the welfare distortion of consumption taxation is found to be marginal compared to income tax.

17. The conclusion is also consistent with standard beliefs in the public finance literature, such as Feldstein (1974), Summers (1981) and Judd (1987), if one does not distinguish the growth rates from the levels of macroeconomic aggregates.

18. To model international variables, one may follow Bovenberg (1986 and 1989).

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APPENDIX
DESCRIPTION OF THE DATA

Y - per capita real private GDP
C - per capita real private consumption expenditure
K - per capita real gross capital owned by private and public enterprises (deflated by the gross investment deflator)
H - index of higher educated population at ages of 6 and over
E - employment rate (percentage of population employed)
L - effective labor (E x H)
GREXR - growth rate of export-import ratio
TREVY - per capita real aggregate tax revenue
TREVC - per capita real commodity tax and customs duties
TREVK - per capita real business tax
TREVL - per capita real income tax
TBASEY - aggregate tax base (Y)
TBASEC - consumption tax base (C)
TBASEK - capital tax base (per capita real capital income)
TBASEL - labor tax base (per capita real labor income)
TRY - aggregate tax rate (TREVY x 100 / TBASEY)
TRL - consumption tax rate (TREVC x 100 / TBASEC)
TRK - capital income tax rate (TREVK x 100 / TBASEK)
TRL - labor income tax rate (TREVL x 100 / TBASEL)

SOURCES: (a) Y, C, XR, TBASE's: computed from the National Income (NI) of the Republic of China (ROC), 1987, Directorate-Generate of Budget, Accounting, and Statistics (DGBAS), and the Taiwan Statistical Data Book (TSDB), 1987, Council for Economic Planning and Development (CEPD).
(b) TREV's: computed from the Yearbook of Financial Statistics of the ROC, 1987, and the Yearbook of Tax Statistics, ROC, 1987, Ministry of Finance.
(c) E: computed from the Yearbook of Labor Statistics, ROC, 1987, DGBAS.
(d) H: computed from the TSDB.
(e) K: computed from the NI and the Input-Output Survey, 1979, CEPD.

NOTES: (a) TREV's are deflated by the government spending deflator; Tax series are computed using 2-year moving average of fiscal-year data.
(b) Y, C, K, TREV's, and TBASE's are in thousands of New Taiwan dollars per person at 1981 constant prices; E, GREXR, and TR's are in percentage points; H is indexed with 1981=1.