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Firm Size and Taxes*

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The scale dependence in firm growth (smaller firms grow faster) is systematically reflected in the size distribution. This paper studies whether taxes affect the equilibrium firm size distribution in a cross-country context. The main finding is that the empirical association between firm growth and corporate tax (VAT) is positive (negative), with notable differences in the response of manufacturing firms and that of the others. We draw implications for recent debate on the impact of taxes and tax avoidance on the organization of firms in the economy.

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1. INTRODUCTION

In this paper we provide new cross-country evidence on the relationship between corporate tax rates and the firm size distribution. Models in which higher tax rates are correlated with lower capital to output ratios (Backus *et al*., 2008), and models in which the larger the capital share, the faster growth rates decline with size (Rossi-Hansberg and Wright, 2007), suggest a possible causation from tax rates to firm size distribution and growth. Together, these models imply that the scale dependence of firm growth, which represents the firm size distribution, should be positively related to the corporate tax rates.

While there is no empirical support to the relationship between tax rates — firm size distribution, a smoking gun from some previous studies suggests that it can be studied and tested in a cross-country context. The main purpose of this paper is to provide two extensions of previous research.[1] The first is to examine conceptually the association between corporate tax rates and firm size. Existing research show that fiscal policy can drive firms' profits and investment; see Alesina *et al*. (2002) and Cummins *et al*. (1996), and firm size distribution and growth; see Alfaro *et al*. (2008). As we present in section 2, given a resource constraint in the economy, tax rates can also influence the scale dependence of firm growth. We show that in a perfectly competitive economy, tax rates are positively correlated with the growth of firm size. Higher tax rates are associated with a lower the number of firms so that in the steady state each remaining firm employs a larger number of labor, thereby enlarging their size and increasing the average growth of firm size in the economy.

The second contribution is to examine empirically the relationship between tax rates and firm size distribution across countries. Existing country-specific evidence shows that there is a significant variation of

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[1] For previous studies on the firm size distributions, see for example Lucas (1978), Evans (1987), Hall (1987), Sutton (1997), Kumar *et al*. (1999), Pagano and Schivardi (2003), and Lotti and Santarelli (2004).

corporate tax rates across time and countries (see Slemrod, 2004a; Devereux *et al*., 2008), and that taxes affect industrial structure and organization forms (see Romanov, 2006; Goolsbee, 2004; Gordon and Slemrod, 2000; Mackie-Mason and Gordon, 1997). In a recent cross-country study, Angelini (2008) focuses on financial constraints and find in an Italian and a Non-OECD sample that firms that declare to be constrained are on average smaller than those that do not, and their firm size distribution is relatively more skewed to the right.[2] We expand the existing evidence of firm growth determination, taking into account the scale dependence, capital share, and corporate tax rates across countries. The baseline estimation confirms previous studies on the effects of scale dependence, capital share, age, and profitability on the firm growth. Our main findings show that the positive association between corporate tax rates and firm growth are important in the sub-samples of non-tax haven countries, OECD countries, non-manufacturing firms, and high-capital share firms.

Section 2 provides the conceptual model, highlighting the effect of tax rates on scale dependence of firm growth. Section 3 discusses the data and presents the empirical findings. Section 4 concludes.

2. CONCEPTUAL FRAMEWORK

There are a number of channels through which taxes can affect the firm size dynamics. In this section, we illustrate one channel by extending Rossi-Hansberg and Wright (2007) model of firm size dynamics with the accumulation of industry-specific human capital. The innovation of our partial-equilibrium model is that taxes reduce resources availability in the economy so that higher corporate tax rates are associated with a lower the number of perfectly-competitive firms, and enlarge the size of the remaining

[2] Using a data set of Portuguese firms, Cabral and Mata (2003) show that financial constraints can explain the right-skewed firm size distribution. See also Rajan and Zingales (2001), Cooley and Quadrini (2001), and Carpenter and Petersen (2002).

firms in the steady state.

Consider an economy in which each member of households is identical, endowed with one unit of labor, and has a preference over the aggregate consumption streams (C_t). The number of households (L_t) exogenously grows at the rate of (g_L). We assume a well-behaved preference u — increasing and strictly concave. Accordingly, the aggregate households welfare can be expressed as

$$E_0\left[\sum_{t=0}^{\infty}\delta^t L_t u\left(\frac{C_t}{L_t}\right)\right], \tag{1}$$

where δ is the households discount factor, and E_0 is the expectation operator conditional upon available information at the time beginning. The households face the following final outputs constraint:

$$C_t + \sum_{j=1}^{J} I_{tj} \le \sum_{j=1}^{J} Q_{tj}, \tag{2}$$

where Q_{tj} is the final output produced by firms $j=1, ..., J$, and I_{tj} is the investment in physical capital by households. The final output constraint implies that final goods can be used for either consumption or investment.

There are two factors of production: physical capital (K_{jt}) and labor (L_{jt}). The law of motion for physical capital accumulation takes the log-linear form:

$$K_{t+1j} = K_{tj}^{\sigma_j} I_{tj}^{1-\sigma_j}, \tag{3}$$

σ_j captures the rate of depreciation and the relative importance of investment in capital — $\sigma_j = 0$ implies that capital is completely depreciated, and the investment fully contributes to capital stock in next period. Since each member of households are endowed with a unit of labor, the labor employment by each firm j (L_{tj}) is constrained by $\sum_{j=1}^{J} L_{t\,j} \leq L_{\cdot t}$

In addition to physical capital and labor, households are endowed with industry-specific human capital (H_{tj}), which also accumulates according to the following log-linear form:

$$H_{t+1j} = A_{t+1j} H_{tj}^{\omega_j} E_{tj}^{1-\omega_j}, \qquad (4)$$

where the productivity shock, $A_{t+1j} \in \left[\underline{A}_j,\ \overline{A}_j \right]$ is *i.i.d.* distributed, and E_{tj} is the industry-specific investment in human capital. ω_j captures the relative importance of the existing human capital and its investment in human capital stock in next period. We assume that human capital investment requires final output, and hence the production constraint of firms is $Q_{tj} + E_{tj} \leq Y_{tj}$.

In each period t, a firm has to pay a fixed cost F_j denominated in terms of final output up front, and produces a numeraire whose price is normalized to unity, and production function takes the standard Cobb-Douglas form. There are several ways to introduce the tax parameter into the model: taxes on returns to capital, taxes on profits, and indirect taxes (such as value added taxes and property taxes, etc.).[3] We focus on the tax rates (τ) that are time-invariant and are uniformly levied on local production of final output, in order to capture the extent to which higher taxes lead to a lower level of output; higher tax rates increase total production cost so that firms have to cut their production down to maintain their profitability. Accordingly, the aggregate final output production in an economy can be written as

$$Y_{tj} = (1-\tau)\left[K_{tj}^{\alpha_j} \left(H_{tj}^{\beta_j} L_{tj}^{1-\beta_j} \right)^{1-\alpha_j} \right]^{\gamma_j} \mu_{tj}^{1-\gamma_j} - F_j \mu_{tj}, \qquad (5)$$

where μ_{tj} is the number of firms; $\alpha_j \in [0,\ 1]$ is the share of capital in total

[3] See also Backus *et al*. (2008) and Desai *et al*. (2004).

production cost; $\beta_j \in [0, 1]$ captures the share of capital in total labor cost;[4)] and $\gamma_j \in [0, 1]$ implies that the technology is decreasing returns to scale.

In equilibrium, the optimal number of firms is chosen such that the aggregate welfare function (1) is maximized, subject to the final output constraint (2) and the aggregate final output production (5). For computational simplicity, we focus on the symmetric solution. The first-order condition corresponding to the constrained maximization problem is:

$$F_j = (1-\tau)(1-\gamma_j)\left[K_{tj}^{\alpha_j}(H_{tj}^{\beta_j}L_{tj}^{1-\beta_j})^{1-\alpha_j}\right]\mu_{tj}^{-\gamma_j}. \tag{6}$$

Therefore, the optimal number of firms as a function of production factors and tax rates can be expressed as

$$\mu_{tj} = \left[\frac{(1-\tau)(1-\gamma_j)}{F_j}\right]^{\frac{1}{\gamma_j}} K_{tj}^{\alpha_j}(H_{tj}^{\beta_j}L_{tj}^{1-\beta j})^{1-\alpha_j}. \tag{7}$$

The optimal number of firms is decreasing in tax rates $(\partial\mu_{tj}/\partial\tau < 0)$. Higher tax rates essentially reduce the production of final output and lower the number of firms in the perfectly competitive market. Define firm size as the average number of labor employed by each firm. By using (7), we obtain the equilibrium firm size (s_{ij}) as

$$s_{tj} \equiv \frac{L_{tj}}{\mu_{tj}} = \left[\frac{F_j}{(1-\tau)(1-\gamma_j)}\right]^{\frac{1}{\gamma_j}}\left(\frac{L_{tj}}{K_{tj}}\right)^{\alpha_j}\left(\frac{L_{tj}}{H_{tj}}\right)^{\beta_j(1-\alpha_j)}. \tag{8}$$

The equilibrium size of a firm is increasing in tax rates $(\partial s_{tj}/\partial\tau)$. Higher tax rates reduce the optimal number of firms, so that each surviving

4) From (5), human capital augments the efficiency units of labor, and is therefore labor-augmenting.

firm will on average employ more production factors (physical capital, human capital, and labor) available in the economy: higher tax rates enlarge the equilibrium firm size.

The effect of higher tax rates on the growth rate of firm size can also be derived from the equilibrium firm size. Consider a zero growth rate of population $(g_L = 0)$,[5] using (4), (8), and the final output constraint, the growth of firm size in steady state is

$$\ln s_{t+1j} - \ln s_{tj} = C_j - \frac{1}{\gamma_j}(1-\omega_j)\ln(1-\tau) - (1-\omega_j)(1-\beta_j + \alpha_j\beta_j)\ln s_{tj} - \beta_j(1-\alpha_j)\ln A_{t+1j}, \quad (9)$$

where C_j is a constant term, which is a function of K_j, N_j, F_j, α_j, β_j, and γ_j. Our stylized model shows that higher corporate tax rates tend to increase the growth of firm size, $\partial(\ln s_{t+1j} - \ln s_{tj}) / \partial \ln \tau > 0$.

We summarize the key implications of our model as follows: In a perfectly competitive economy, higher corporate tax rates are positively correlated with the growth of firm size. In steady state each remaining firms employ a larger number of labor, thereby enlarging their size and increasing the average growth of firm size in the economy.

3. EMPIRICAL ANALYSIS

The empirical analysis builds on the firm level information in the OSIRIS database. From 1997-2008, OSIRIS compiled the data of 40,863 firms in 139 countries disaggregated into 9 industries (Data Appendix provides the detail description). In the cross-country context, there are at least two alternative sources of firm level data: the WorldBase data studied by Alfaro

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[5] Ones can easily derive the growth of firm size when population is allowed to grow exogenously at a positive rate, without changes in our main results.

et al. (2008) and the WBES data studied by Angelini (2008). The former contains more than 20 million establishments, but not financial and operation data; the latter contains less than 4,000 firms, but with extra firm level information, including whether firms are financially constrained. In comparison to these two alternatives, the size and depth of firm-level information guide us that OSIRIS data set is more appropriate to test equation (9) across countries and years.[6]

3.1. Tax Rates (τ)

We focus on the statutory corporate tax rates. Although we could also use the ratio of tax revenue to GDP, but this measure of average tax rates is subject to data limitation and a variation of tax collection costs across countries.[7] Table 1 reports the equally-weighted average statutory tax rates from 1997 to 2006, for corporate income, personal income, and value-added tax (VAT). Tax rates are higher in OECD than Non-OECD countries, with the largest difference in the personal income taxes (12.2%), followed by VAT (4.7%) and corporate income taxes (3.1%). The rates in tax havens are clearly much lower. The dispersion of tax rates tends to be higher among the Non-OECD countries. We can also see that while the corporate income and personal income tax rates have declined during the period, the VAT rates have increased, the trend that reflects the global shift of tax bases.[8] The correlation analysis suggests that the corporate tax rates are positively associated with the personal tax rates, whereas they are weakly associated with the VAT rates in the Non-OECD countries.

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[6] Other potential databases, but with less comprehensive and comparable information across countries, include Bureau van dijk (BvD) Amadeus for Europe (constructed from national registries), Icarus for US (constructed from Dunn & Bradstreet), and Oriana for China (constructed from Huaxia credit) and Japan (constructed from Teikoku database); CMIE Firstsource dataset for India (constructed from Registry of Companies).

[7] See Plesko (2003) for the differences across alternative measures of corporate tax rates.

[8] See Aizenman and Jinjarak (2009).

Table 1 Tax Rates

Country	1997-2006		1997-2001		2002-2006	
	Avg.	Std.	Avg.	Std.	Avg.	Std.
Corporate Income Tax						
OECD	31.0	2.7	32.6	1.9	29.3	1.7
Non-OECD	27.9	3.3	29.6	1.1	26.2	2.7
Tax Havens	20.3	3.1	21.2	1.1	19.1	2.8
Personal Income Tax						
OECD	40.2	2.9	42.2	1.9	39.0	1.6
Non-OECD	28.0	2.6	29.2	0.7	27.3	1.9
Tax Havens	20.5	1.7	21.0	0.8	20.1	1.6
Value-Added Tax						
OECD	16.0	0.6	15.8	0.1	16.2	0.5
Non-OECD	11.3	1.7	10.7	1.4	11.7	1.2
Tax Havens	7.6	0.6	7.1	0.4	7.8	0.4

Correlations		Corporate	Personal
Personal	All Countries	0.4431*	
	OECD	0.4850*	
	Non-OECD	0.4167*	
	Tax Havens	0.6352*	
VAT	All Countries	0.2488*	0.3725*
	OECD	–0.0333	0.2424
	Non-OECD	0.2618*	0.3188*
	Tax Havens	0.5992*	0.2313

Notes: The top panel reports the average and standard deviation of statutory tax rates, equally weighted across countries. The list of countries in OECD, Non-OECD, and Tax Havens is in the Data Appendix. The bottom panel provides the correlations between tax rates. * signifies statistical significant at 5 percent level.

3.2. Capital Shares (α_j)

We compute the sectoral capital share based on the US industry data compiled by the US Bureau of Economic Analysis (BEA). Table 2 summarizes the capital shares, averaged over the periods 1987-1996 and

Table 2 Capital Shares

Sector	Average Capital Share (%)		Growth 1987-2006 (%)		
	1987-1996	1997-2006	Est.	S.E.	*p*-value
Agriculture	76.5	70.4	–0.6205	0.1298	0.0001
Mining	61.3	70.4	0.9645	0.1776	0.0000
Construction	32.8	32.3	0.0271	0.0599	0.6568
Manufacturing	34.8	38.4	0.2244	0.0655	0.0030
Transportation	34.7	37.0	0.0869	0.0587	0.1562
Wholesale	47.1	47.2	0.0211	0.0546	0.7033
Retail	42.7	44.1	0.0492	0.0458	0.2963
Finance	77.1	75.8	–0.1995	0.0273	0.0000
Services	31.1	30.1	–0.2159	0.0605	0.0022

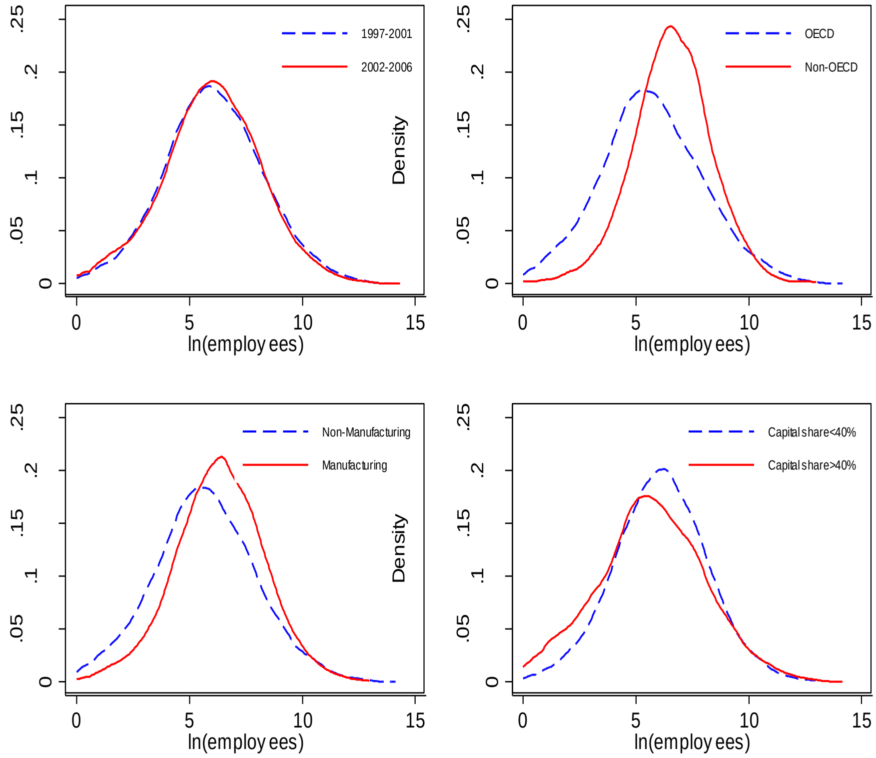
Notes: The sectoral capital share is approximated from the US industry data, using the US Bureau of Economic Analysis (BEA) data. For each sector, the capital share is constructed as one minus the share of compensation of employees in the value added. The growth rate of capital share is estimated from a regression of each sectoral capital share on a time trend for the annual periods of 1987-2006 (20 observations for each sector).

1997-2006. Throughout, the capital share is highest in Finance and lowest in Services. For the 20-year period from 1987-2006, the capital share increased in Mining (0.96%) and Manufacturing (0.22%), but decreased in Agriculture (–0.62%), Finance (–0.19%), and Services (–0.21%). While the capital shares have not changed substantially across industries, we use the 1987-1996 shares for our analysis on the firm size distribution during 1997-2006 to avoid multicollinearity and endogeneity issues.

3.3. Empirical Firm Size Distribution

Figure 1 provides the firm size distribution plots. While the firm size distributions of the 1997-2001 and the 2002-2006 periods are similar, there are some noticeable differences on the firm size distributions when we disaggregate

Figure 1 Density of Firm Size Distribution



Note: This figure plots the empirical density function on a natural logarithmic (ln) scale, based on the OSIRIS data set.

firms into OECD/Non-OECD, Manufacturing/Non-Manufacturing, and Capital Share>40%/Capital Share<40%. To test these differences, we first examine whether the firm size distribution is characterized by the proportionate growth process, which gives rise to the lognormal distribution. We run a regression of the firm size growth on the average firm size between two periods

$$\frac{s_{2002-2006}}{s_{1997-2001}} = \hat{a} + \hat{b}\,\frac{s_{2002-2006} + s_{1997-2001}}{2}. \qquad (10)$$

Table 3 Empirical Firm Size Distribution in OSIRIS Data Set

	Number of Firms	Average Size (Employe-es)	Skewness		Kurtosis		Gibrat's Coefficient	Zipf's Coefficient
			Estimate	*p*-value	Estimate	*p*-value	Estimate (Std. dev.)	Estimate (Std. dev.)
1998-2007	25,681	3,642	24.4	0.000	1255.3	0.000	–0.36(0.15)	–0.42(0.00)
OECD	17,091	3,844	24.5	0.000	1229.8	0.000	–0.48(0.17)	–0.40(0.00)
Non-OECD	8,212	3,327	17.2	0.000	386.5	0.000	0.05(0.34)	–0.51(0.01)
Manufacturing	11,956	3,633	13.4	0.000	249.9	0.000	–0.57(0.38)	–0.45(0.00)
Non-Manufacturing	13,725	3,649	26.8	0.000	1342.6	0.000	–0.26(0.10)	–0.40(0.00)
Capital Share <40%	18,825	3,450	13.4	0.000	244.8	0.000	–0.51(0.24)	–0.44(0.00)
Capital Share >40%	6,856	4,168	27.6	0.000	1253.1	0.000	–0.20(0.11)	–0.38(0.00)

Table 3 reports the estimate, also known as the Gibrat coefficient, of –0.36 and statistically significant at 1 percent level. The growth rate of firm size therefore depends negatively on the size of the firm: smaller firms on average do grow faster than larger firms. At a more disaggregated level, we can also see in the fifth column of table 3 that the Gibrat coefficient is statistically significant for the firm size distributions in OECD, Non-Manufacturing, and sector with capital share < 40%.

The upper tail of the firm size distribution has often been described by Pareto distributions: $\Pr[s \geq s_j] = (\frac{s_0}{s_j})^{\kappa}, \quad s_j \geq s_0, \quad \kappa > 0$ where s_0 is the minimum size. We estimate the coefficients of the tail distribution, also known as the Zipf's coefficient:[9]

$$\ln[P(s_0 \geq s_j)] = \psi + \kappa \ln s_j. \tag{11}$$

[9] Other applications of Zipf's law include cities (Eeckhout, 2004) and financial markets (Gabaix *et al*., 2006).

As shown in the last column table 3, for firms in the whole sample and at disaggregated level, the tails are thinner than the Pareto. This finding is difference from Rossi-Hansberg and Wright (2007) and Axtell (2001) in the sample of U.S. firms where the Zipf's coefficient is close to one. The difference between the US and the international sample is underlined by the fact that the former includes all establishments, whereas the latter is comprised of enterprises.

3.4. Econometric Specification

We examine the empirical relationship between the growth rates of firm size, $\frac{s_{t+1j}}{s_{tj}}$, tax rates τ_j, and average capital share α_j, for the period 1997-2006 by estimating equation (9):

$$\ln\left(\frac{s_{t+1j}}{s_{tj}}\right) = \tilde{a}_j + \tilde{b}\ln(1-\tau_j) + \tilde{c}\ln s_{tj} + \tilde{d}\alpha_j \ln s_{tj} + \tilde{e}\ln A_{t+1j}, \qquad (12)$$

where $\tilde{a}_j = C_j$, $\tilde{b} = -\frac{1}{\gamma_j}(1-\omega_j)$, $\tilde{c} = -(1-\omega_j)(1-\beta_j)$, $\tilde{d} = -(1-\omega_j)\beta_j$, $\tilde{e} = -\beta_j(1-\alpha_j)$.

The conceptual framework predicts that $\tilde{b}$ and $\tilde{d}$ should be negative and significant, and $\tilde{e}$ be positive. Like in Rossi-Hansberg and Wright (2007), the larger the capital share, the faster growth rates decline with size, so that $\tilde{d} < 0$. As in Angelini (2008), we expect $\tilde{e} > 0$. To take into account other firm and sector specific factors, we include for $\tilde{a}_j$ firm's age and sectoral capital share from 1987-1996. To summarize,

$$\ln\left(\frac{s_{t+1j}}{s_{tj}}\right) = \underset{(+,\,-)}{\tilde{a}_j} + \underset{(-)}{\tilde{b}(1-\tau_j)} + \underset{(-)}{\tilde{c}\ln s_{tj}} + \underset{(-)}{\tilde{d}\ln s_{tj}} + \underset{(+)}{\tilde{e}\ln A_{t+1j}}.$$

3.5. Results

Table 4 reports the baseline estimation. While our focus is on the corporate tax rates, throughout we also provide the estimates using the personal income and the value added tax rates. To allow for tax policy in tax havens and the rest, the top half of table 4 reports the estimates from the sample excluding firms in tax havens, whereas the bottom half includes all firms. As predicted by our conceptual framework, the corporate tax rates are positively associated with firm size: raising the corporate tax rates by 5% increases the average growth of firm size by 3%. The estimation also shows that scale dependence increases with the sectoral capital shares. The coefficient estimate on the capital share is positive and statistically significant. In line with the previous studies, lagged firm size, age, and return on assets have the expected effects on the firm size.

Table 5 contrasts firms in OECD and Non-OECD countries. The coefficient estimates on lagged firm size, age, and return on assets have the expected signs. Corporate tax rates have a negative relationship with firm size in the sample of OECD countries. This means that the large dispersion of tax rates among the Non-OECD as reported in table 1 has yet to significantly influence the firm size distribution. Further, we can also see that splitting the sample into OECD and Non-OECD reduces the significance of capital share in explaining the growth of firm size across countries. Unfortunately, we do not have data on the capital share at country level to examine whether the capital shares do not vary across sectors within and between the OECD and Non-OECD groups.

Table 6 provides the estimates for manufacturing and non-manufacturing sectors. Again, the lagged firm size, age, and return on assets remain statistically significant with expected sign. However, the corporate tax rates are positive and statistically significant only for the non-manufacturing sector. In addition, the value added tax rates are negative and strongly significant to the Manufacturing sector. The difference between the size distribution for firms in intermediate input and final good manufacturing industries may shed

Table 4 Firm Size Growth and Tax Rates: Baseline Estimation

Dependent Variable: Growth of Number of Employees from t to $t+1$	Tax Rates		
	Corporate Income Tax	Personal Income Tax	Value-Added Tax
	Coeff. (Std.)	Coeff. (Std.)	Coeff. (Std.)
	Excluding Firms in Tax Haven Countries		
ln(1–Tax Rates$_t$)	–0.60 (0.17)***	–0.21 (0.06)***	0.07 (0.11)
Capital Share$_t$	0.35 (0.17)**	0.38 (0.17)**	0.42 (0.17)**
ln(Employees$_t$)	–0.03 (0.01)**	–0.03 (0.01)**	–0.02 (0.01)*
Average Capital Share*ln(Employees$_t$)	–0.05 (0.03)**	–0.05 (0.03)*	–0.06 (0.03)**
ln(Age)	–0.06 (0.01)***	–0.06 (0.01)***	–0.06 (0.01)***
ln(Return on Assets$_t$)	0.06 (0.01)***	0.06 (0.01)***	0.06 (0.01)***
R-sq.	0.07	0.07	0.07
Number of Firms	4,622	4,622	4,622
	All Firms		
ln(1–Tax Rates$_t$)	–0.16 (0.11)	–0.12 (0.05)**	0.09 (0.10)
Capital Share$_t$	0.21 (0.17)	0.21 (0.17)	0.23 (0.17)
ln(Employees$_t$)	–0.04 (0.01)***	–0.04 (0.01)***	–0.03 (0.01)***
Average Capital Share*ln(Employees$_t$)	–0.03 (0.03)	–0.03 (0.03)	–0.04 (0.03)
ln(Age)	–0.06 (0.01)***	–0.06 (0.01)***	–0.06 (0.01)***
ln(Return on Assets$_t$)	0.06 (0.01)***	0.06 (0.01)***	0.06 (0.01)***
R-sq.	0.07	0.07	0.07
Number of Firms	5,035	5,035	5,035

Notes: This table provides the estimates obtained from the regression equation (12). t denotes years 1997-2001 and $t+1$ denotes 2002-2006. The growth rates of firm size are between t and $t+1$. Tax Rates are the average statutory rates. Average Capital Share is the average between t and $t+1$. Return on assets is the profits before taxes. Standard errors are in parentheses. *** (**, *) represents statistically significant at 1 (5, 10) percent level.

light on the forces that determine the effects of the value added tax rates; a frequently cited advantage of the value added taxes is that this tax is collected

Table 5 Estimation Results: OECD and Non-OECD Countries

Dependent Variable: Growth of Number of Employees from t to t+1	Tax Rates		
	Corporate Income Tax	Personal Income Tax	Value-Added Tax
	Coeff. (Std.)	Coeff. (Std.)	Coeff. (Std.)
	Firms in OECD		
ln(1–Tax Rates$_t$)	–0.51 (0.19)***	–0.12 (0.07)*	0.03 (0.11)
Capital Share$_t$	0.09 (0.18)	0.10 (0.18)	0.13 (0.18)
ln(Employees$_t$)	–0.04 (0.01)***	–0.04 (0.01)***	–0.03 (0.01)**
Average Capital Share*ln(Employees$_t$)	–0.01 (0.03)	–0.01 (0.03)*	–0.01 (0.03)
ln(Age)	–0.06 (0.01)***	–0.06 (0.01)***	–0.06 (0.01)***
ln(Return on Assets$_t$)	0.06 (0.01)***	0.06 (0.01)***	0.06 (0.01)***
R-sq.	0.08	0.08	0.08
Number of Firms	3,669	3,669	3,669
	Firms in Non-OECD		
ln(1–Tax Rates$_t$)	0.05 (0.15)	–0.12 (0.11)	0.31 (0.26)
Capital Share$_t$	0.09 (0.38)	0.09 (0.38)	0.13 (0.38)
ln(Employees$_t$)	–0.08 (0.03)***	–0.09 (0.03)***	–0.08 (0.03)**
Average Capital Share*ln(Employees$_t$)	–0.01 (0.06)	–0.01 (0.06)	–0.02 (0.06)
ln(Age)	–0.09 (0.02)***	–0.09 (0.02)***	–0.10 (0.02)***
ln(Return on Assets$_t$)	0.05 (0.02)***	0.05 (0.02)***	0.05 (0.02)***
R-sq.	0.08	0.09	0.09
Number of Firms	1,366	1,366	1,366

Notes: This table provides the estimates obtained from the regression equation (12). t denotes years 1997-2001 and t+1 denotes 2002-2006. The growth rates of firm size are between t and t+1. Tax Rates are the average statutory rates. Average Capital Share is the average between t and t+1. Return on assets is the profits before taxes. Standard errors are in parentheses. *** (**, *) represents statistically significant at 1 (5, 10) percent level.

Table 6 Estimation Results: Manufacturing and Non-Manufacturing Industries

Dependent Variable: Growth of Number of Employees from t to t+1	Tax Rates		
	Corporate Income Tax	Personal Income Tax	Value-Added Tax
	Coeff. (Std.)	Coeff. (Std.)	Coeff. (Std.)
	Manufacturing Firms		
ln(1–Tax Rates$_t$)	0.15 (0.14)	–0.06 (0.07)	0.34 (0.14)**
Capital Share$_t$			
ln(Employees$_t$)	–0.06 (0.01)***	–0.06 (0.01)***	–0.06 (0.01)***
Average Capital Share*ln(Employees$_t$)			
ln(Age)	–0.04 (0.01)***	–0.05 (0.01)***	–0.04 (0.01)***
ln(Return on Assets$_t$)	0.06 (0.01)***	0.06 (0.01)***	0.06 (0.01)***
R-sq.	0.09	0.09	0.10
Number of Firms	2,674	2,674	2,674
	Non-Manufacturing Firms		
ln(1–Tax Rates$_t$)	–0.41 (0.16)**	–0.16 (0.08)**	–0.09 (0.15)
Capital Share$_t$	0.41 (0.21)**	0.42 (0.21)**	0.39 (0.21)*
ln(Employees$_t$)	–0.00 (0.02)	–0.01 (0.02)	–0.01 (0.02)
Average Capital Share*ln(Employees$_t$)	–0.07 (0.03)**	–0.07 (0.03)**	–0.07 (0.03)**
ln(Age)	–0.07 (0.01)***	–0.07 (0.01)***	–0.07 (0.01)***
ln(Return on Assets$_t$)	0.06 (0.01)***	0.06 (0.01)***	0.06 (0.01)***
R-sq.	0.06	0.06	0.06
Number of Firms	2,361	2,361	2,361

Notes: This table provides the estimates obtained from the regression equation (12). t denotes years 1997-2001 and t+1 denotes 2002-2006. The growth rates of firm size are between t and t+1. Tax Rates are the average statutory rates. Average Capital Share is the average between t and t+1. Return on assets is the profits before taxes. Standard errors are in parentheses. *** (**, *) represents statistically significant at 1 (5, 10) percent level.

Table 7 Estimation Results: Low and High Capital Share Sectors

Dependent Variable: Growth of Number of Employees from t to t+1	Tax Rates		
	Corporate Income Tax	Personal Income Tax	Value-Added Tax
	Coeff. (Std.)	Coeff. (Std.)	Coeff. (Std.)
	Capital Share$_t$ < 40%		
ln(1–Tax Rates$_t$)	–0.02 (0.12)	–0.06 (0.06)	0.11 (0.11)
Capital Share$_t$	7.52 (1.94)***	7.61 (1.94)***	7.49 (1.93)***
ln(Employees$_t$)	0.24 (0.06)***	0.24 (0.06)***	0.24 (0.06)***
Average Capital Share*ln(Employees$_t$)	–0.84 (0.18)***	–0.84 (0.18)***	–0.84 (0.18)***
ln(Age)	–0.05 (0.01)***	–0.05 (0.01)***	–0.05 (0.01)***
ln(Return on Assets$_t$)	0.06 (0.01)***	0.06 (0.01)***	0.07 (0.01)***
R-sq.	0.09	0.09	0.09
Number of Firms	3,934	3,934	3,934
	Capital Share$_t$ > 40%		
ln(1–Tax Rates$_t$)	–0.42 (0.22)*	–0.26 (0.12)**	0.12 (0.24)
Capital Share$_t$	0.76 (0.45)*	0.75 (0.45)*	0.80 (0.46)*
ln(Employees$_t$)	0.04 (0.05)	0.03 (0.05)	0.04 (0.05)
Average Capital Share*ln(Employees$_t$)	–0.13 (0.07)*	–0.12 (0.07)*	–0.13 (0.07)*
ln(Age)	–0.08 (0.02)***	–0.08 (0.02)***	–0.07 (0.02)***
ln(Return on Assets$_t$)	0.05 (0.02)**	0.05 (0.02)**	0.05 (0.02)**
R-sq.	0.06	0.06	0.05
Number of Firms	1,101	1,101	1,101

Notes: This table provides the estimates obtained from the regression equation (12). t denotes years 1997-2001. t and t+1 denotes 2002-2006. The growth rates of firm size are between t and t+1. Tax Rates are the average statutory rates. Average Capital Share is the average between t and t+1. Return on assets is the profits before taxes. Standard errors are in parentheses. *** (**, *) represents statistically significant at 1 (5, 10) percent level.

throughout the production chain. Our conceptual framework focuses, however, on a production of final goods, and therefore it is beyond the scope of this paper to evaluate effects of the value added taxes.

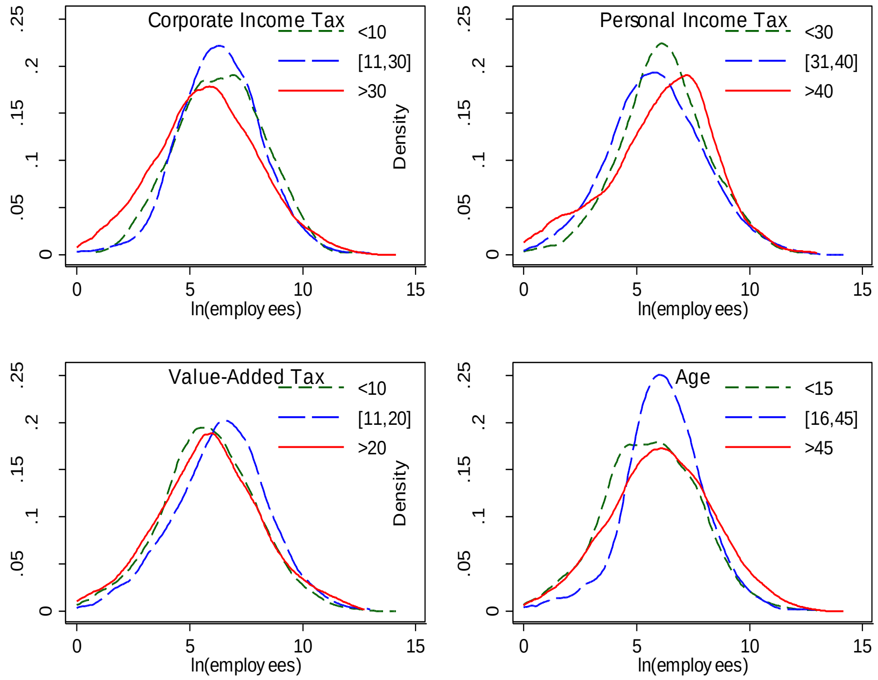
Table 7 presents separately the estimates for the low and the high capital share sectors. This dichotomy provides similar results to the estimation on the whole sample reported in table 4. However, we can see that the corporate tax rates have positive but significant only to the growth of firm size in the high capital share sectors. For the low capital share sectors, the estimation and large coefficient estimates on the capital share itself are driven by the high growth rates of the manufacturing sectors. Although our conceptual framework does not capture the interaction between tax rates and capital shares, the results in table 7 suggest that this issue deserves further investigation.

3.6. Discussion

The questions remain: (i) what is the difference between the effects on firm growth of corporate, personal income, and value added tax rates; (ii) what is the relation between the effects of corporate tax rates and sectoral capital shares. On (i), figure 2 plots the empirical firm size distribution for various levels and types of tax rates, and summarized in table 8. While the level of tax brackets are chosen arbitrary, we can see that the skewness and the peakedness of the firm size distribution increase with the corporate tax rates, but not with the personal income and value added tax rates, or firm's age. These empirical characteristics help explain the positive and large effects of the corporate tax rates, comparing to the personal income and value added tax rates in table 4. Hence, while our conceptual framework does not accommodate the personal and value added tax rates, future investigation should allow this non-linearity.

To delve further into the interaction between the corporate tax rates and the sectoral capital shares, we estimate the Zipf's regression

Figure 2 Tax Rates and Density of Firm Size Distribution



Note: This figure plots the empirical density function on a natural logarithmic (ln) scale across tax rates (%) and firm age (years), based on the OSIRIS data set.

$$\ln[P(employees > x)] = \hat{\varphi}_0 + \hat{\varphi}_1 \ln(employees),$$

for firms disaggregated into four categories based on the corporate tax rates and sectoral capital shares. The results are in table 9, which shows that the estimate of $\hat{\varphi}_1$ is negative and statistically significant. The coefficient estimate for $\alpha < 0.4,\ \tau^c > 0.3$ is higher (in absolute term) than for $\alpha > 0.4,\ \tau^c < 0.3.$ For $\alpha > 0.4,$ lower corporate tax rates result in a lower estimate (in absolute term) than the Zipf's coefficient (which is one). As illustrated in figures 3 and 4, the tails of firm size distribution are thinner than the Pareto, but the difference is larger for the high capital share and low tax rate, $\alpha > 0.4,\ \tau^c < 0.3.$

Table 8 Tax Rates and Firm Size Density in the OSIRIS Data Set

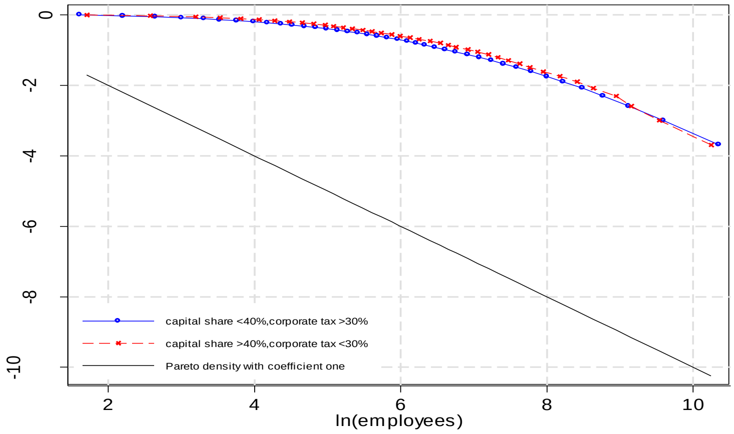
	ln(employees)	Std. Dev.	Skewness	Kurtosis
Corporate Income Tax				
< 10	6.352	1.913	–0.004	2.688
[11, 30]	6.342	1.825	–0.013	3.444
> 30	5.759	2.282	0.044	2.841
Personal Income Tax				
< 30	6.203	1.945	–0.021	3.243
[31, 40]	5.878	2.124	0.093	3.022
> 40	6.109	2.327	–0.382	2.971
Value-Added Tax				
< 10	5.835	2.125	–0.009	3.049
[11, 20]	6.342	2.103	–0.151	3.085
> 20	5.851	2.292	0.038	2.973
Age				
< 15	5.644	2.100	–0.001	2.951
[16, 45]	6.197	1.770	–0.194	3.877
> 45	6.084	2.303	–0.025	2.790

Table 9 Firm Size Distribution, Capital Shares and Corporate Tax Rates

$$\ln[P(employees > x)] = \hat{\varphi}_0 + \hat{\varphi}_1 \ln(employees)$$

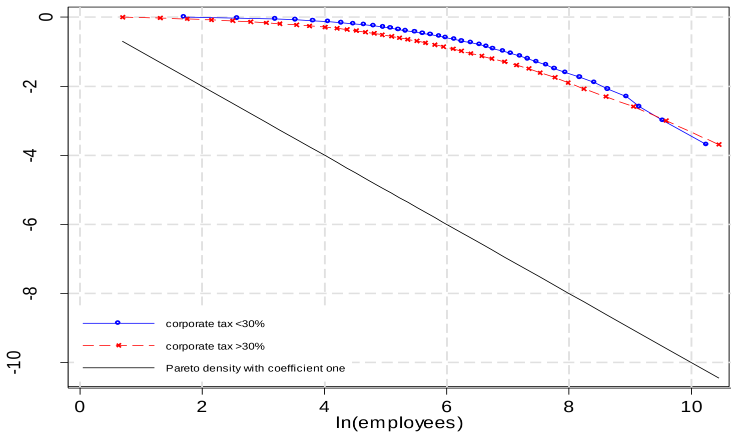
Capital Share (α) Corporate Tax (τ^c)	Est.	S.E.	*p*-value	R^2	Size Bins
$\alpha < 0.40,\ \tau^c < 0.30$	–0.5090	0.5616	0.0000	0.8808	40
$\alpha < 0.40,\ \tau^c > 0.30$	–0.3944	0.0411	0.0000	0.8732	40
$\alpha > 0.40,\ \tau^c > 0.30$	–0.3535	0.0370	0.0000	0.8701	40
$\alpha > 0.40,\ \tau^c < 0.30$	–0.4133	0.0491	0.0000	0.8522	40

Figure 3 Distribution of Firm Sizes by Capital Share and Corporate Tax Rates, 2002-2006



Notes: The figure presents the probability that firms are larger than a particular size against that size in 1997-2001. It also presents the same probability for a Pareto density with coefficient one. The data on the number of firms are aggregated into 40 bins, based on the OSIRIS data set.

Figure 4 Distribution of Firm Sizes in High Capital Share Sectors, 2002-2006



Notes: The figure presents the probability that firms in high capital share sectors (capital share>40%) are larger than a particular size against that size in 1997-2001. It also presents the same probability for a Pareto density with coefficient one. The data on the number of firms are aggregated into 40 bins, based on the OSIRIS data set.

4. CONCLUSION

This paper has examined the hypothesis that the scale dependence of firm growth, which represents the firm size distribution, is positively related to the corporate tax rates. The main contributions of our paper have been to present a model linking the corporate tax rates and firm size, and to report their empirical association in a cross-country sample. The baseline estimation confirm previous studies on the effects of scale dependence, capital share, age, and profitability on the firm growth. Our key results show that the positive association between corporate rates and firm growth are important in the sub-samples of non-tax haven countries, OECD countries, non-manufacturing firms, and high-capital share firms.

Although our findings show that on average the corporate tax rates are positively associated with the growth of firm size, we do not portray to determine what would be the optimal rates for the firm growth and size distribution. Given the importance of firm size distribution to economic growth, we observe in the data that in so far that the role of corporate taxation is clearly evident in the OECD countries and non-manufacturing sectors. The insignificance of corporate tax rates on the firm size distributions in the developing countries does not imply that taxation there is irrelevant. Instead, it is more likely that the effects of taxation on firm size distributions among the developing countries would be sensitive to alternative sources of data, alternative measures of firm size, alternative measures of effective tax rates, and the existence of shadow economies; see Dabla-Norris *et al*. (2008), Johnson *et al*. (2007), Gordon and Li (2007), Slemrod (2004b), and Schneider and Enste (2000). Studying the relationship between taxation and firm size could also be further complicated by the changing composition of tax bases across the countries, though we present in this paper some evidence that the effects of personal income and value added tax rates are insignificant in our sample.

There are still a number of issues not answered in our paper. Our conceptual model and empirical framework assume the causation from corporate tax rates to firm size distribution. Since the reverse causation cannot be ruled out, one useful extension is to examine firm size as a proxy for the firm's political costs as in Zimmerman (1983). It is also interesting to explore in the cross-country data the relationship between local industry turnover, the disappearance of old-fashioned and declining sectors such as agriculture or mining, and taxation, as some recent studies have shown that the industry churning is an important determinant to the growth process; see Duranton (2007) and Findeisen and Südekum (2008). Future works can also be extended to study the firm size distribution and wages (Oi and Idson, 1999), which in a cross-country context is related to firm boundary, multinational corporations, and international trade along the lines of Bernard and Jansen (2007) and Antràs and Helpman (2004).

DATA APPENDIX

The data is collected on annual basis from 1992-2006.

Tax Rates: PriceWaterhouse Center for Transnational Taxation' Corporate Taxes and Individual Taxes, Deloitte Touche Tohmatsu's International Tax and Business Guides, Coopers & Lybrand' 1998 International Tax Summaries, and KPMG International's Corporate Tax Rate Survey (various issues).

Capital Share: US Bureau of Economic Analysis (BEA)

Firm-level Characteristics: OSIRIS (Bureau van Dijk)
Size: Number of Employees
Age: Date of Incorporation
Return on Assets: Net Income/Total Assets

Sectoral Classification:

Division 1: Agriculture, Forestry, and Fishing	SIC 01: Agricultural Production Crops; SIC 02: Agriculture production livestock and animal specialties; SIC 07: Agricultural Services; SIC 08: Forestry; SIC 09: Fishing, hunting, and trapping
Division 2: Mining	SIC 10: Metal Mining; SIC 12: Coal Mining; SIC 13: Oil And Gas Extraction; SIC 14: Mining and Quarrying Of Nonmetallic Minerals, Except Fuels
Division 3: Construction	SIC 15: Building Construction General Contractors And Operative Builders; SIC 16: Heavy Construction Other Than Building Construction Contractors; SIC 17: Construction Special Trade Contractors
Division 4: Manufacturing	SIC 20: Food And Kindred Products; SIC 21: Tobacco Products; SIC 22: Textile Mill Products; SIC 23: Apparel And Other Finished Products Made From Fabrics And Similar Materials; SIC 24: Lumber And Wood Products, Except Furniture; SIC 25: Furniture And Fixtures; SIC 26: Paper And Allied Products; SIC 27: Printing, Publishing, And Allied Industries; SIC 28: Chemicals And Allied Products; SIC 29: Petroleum Refining And Related Industries; SIC 30: Rubber And Miscellaneous Plastics Products; SIC 31: Leather And Leather Products; SIC 32: Stone, Clay, Glass, And Concrete Products; SIC 33: Primary Metal Industries; SIC 34: Fabricated Metal Products, Except Machinery And Transportation Equipment; SIC 35: Industrial And Commercial Machinery And Computer Equipment; SIC 36: Electronic And Other Electrical Equipment And Components, Except Computer Equipment; SIC 37: Transportation Equipment; SIC 38: Measuring, Analyzing, And Controlling Instruments; Photographic, Medical And Optical Goods; Watches And Clocks; SIC 39: Miscellaneous Manufacturing Industries

Division 5: Transportation, Communications, Electric, Gas, and Sanitary Services	SIC 40: Railroad Transportation; SIC 41: Local And Suburban Transit And Interurban Highway Passenger Transportation; SIC 42: Motor Freight Transportation And Warehousing; SIC 43: United States Postal Service; SIC 44: Water Transportation; SIC 45: Transportation By Air; SIC 46: Pipelines, Except Natural Gas; SIC 47: Transportation Services; SIC 48: Communications; SIC 49: Electric, Gas, And Sanitary Services
Division 6: Wholesale Trade	SIC 50: Wholesale Trade-durable Goods; SIC 51: Wholesale Trade-non-durable Goods
Division 7: Retail Trade	SIC 52: Building Materials, Hardware, Garden Supply, and Mobile Home Dealers; SIC 53: General Merchandise Stores; SIC 54: Food Stores; SIC 55: Automotive Dealers And Gasoline Service Stations; SIC 56: Apparel And Accessory Stores; SIC 57: Home Furniture, Furnishings, And Equipment Stores; SIC 58: Eating And Drinking Places; SIC 59: Miscellaneous Retail
Division 8: Finance, Insurance, and Real Estate	SIC 60: Depository Institutions; SIC 61: Non-depository Credit Institutions; SIC 62: Security And Commodity Brokers, Dealers, Exchanges, And Services; SIC 63: Insurance Carriers; SIC 64: Insurance Agents, Brokers, And Service; SIC 65: Real Estate; SIC 67: Holding And Other Investment Offices
Division 9: Services	SIC 70: Hotels, Rooming Houses, Camps, and Other Lodging Places; SIC 72: Personal Services; SIC 73: Business Services; SIC 75: Automotive Repair, Services, And Parking; SIC 76: Miscellaneous Repair Services; SIC 78: Motion Pictures; SIC 79: Amusement And Recreation Services; SIC 80: Health Services; SIC 81: Legal Services; SIC 82: Educational Services; SIC 83: Social Services; SIC 84: Museums, Art Galleries, And Botanical And Zoological Gardens; SIC 86: Membership Organizations; SIC 87: Engineering, Accounting, Research, Management, And Related Services; SIC 88: Private Households; SIC 89: Miscellaneous Services

Country Groups:

OECD	Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Republic of Israel, Italy, Japan, Korea, Republic of Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States
Non-OECD	Argentina, Bahamas, Bahrain, Barbados, Bermuda, Bolivia, Botswana, Brazil, British Virgin Islands, Bulgaria, Cayman Islands, Chile, China, People's Republic of Colombia, Costa Rica, Croatia, Cyprus, Dominican Republic, Ecuador, Egypt, El Salvador, Estonia, Fiji, Gabon, Ghana, Guatemala, Guyana, Honduras, Hong Kong, Hungary, India, Indonesia, Iran, Ivory Coast (Cote d'Lvoire), Jamaica, Kazakhstan, Kenya, Kuwait, Latvia, Liechtenstein, Lithuania, Malawi, Malaysia, Malta, Mauritius, Mexico, Monaco, Morocco, Mozambique, Namibia, Republic of Netherlands Antilles, Nicaragua, Nigeria, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Qatar, Russian Federation, Saudi Arabia, Singapore, Slovak Republic, Slovenia, South Africa, Sri Lanka, St. Lucia, Swaziland, Taiwan, Tanzania, Thailand, Trinidad and Tobago, Uganda, Ukraine, United Arab Emirates, Uruguay, Uzekistan, Republic of Venezuela, Vietnam, Zambia, Zimbabwe
Tax Havens	Bahamas, Bahrain, Barbados, Bermuda, British Virgin Islands, Cayman Islands, Costa Rica, Cyprus, Hong Kong, Ireland, Republic of Liechtenstein, Luxembourg, Malta, Monaco, Netherlands Antilles, Panama, Singapore, St. Lucia, Switzerland, United Arab Emirates, Uruguay

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