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Empirical Evidence on the Effects of Tax Incentives

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Empirical Evidence on the Effects of Tax Incentives

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Abstract

This paper considers two empirical questions about tax incentives: (1) are incentives used as tools of tax competition and (2) how effective are incentives in attracting investment? To answer these, we prepared a new dataset of tax incentives in over 40 Latin American, Caribbean and African countries for the period 1985–2004. Using spatial econometrics techniques for panel data to answer the first question, we find evidence for strategic interaction in tax holidays, in addition to the well-known competition over the corporate income tax rate. We find no evidence, however, for competition over investment allowances and tax credits. Using dynamic panel data econometrics to answer the second question, we find evidence that lower corporate income tax rates and longer tax holidays are effective in attracting FDI, but not in boosting gross private fixed capital formation or growth.

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Keywords: Tax incentives, tax competition, investment.

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I. Introduction

Tax incentives are common around the world, especially in developing countries. A growing literature discusses their likely effects, including their benefits and risks.[2] Despite a generally skeptical assessment by economists, they remain popular policy tools. And, while there are a lot of opinions and some theory on tax incentives, there is relatively little empirical evidence.

The little empirical work that exists falls into three main categories. First, there are a range of case studies on particular countries.[3] While these are often very interesting to read and come to plausible conclusions, it is hard to generalize their findings, which were obtained by observing one country and the development of its incentive system. Second, there a number of studies, which calculate effective marginal tax rates.[4] Again, these are often useful exercises, as they can reveal the incentives for investment created by the tax system (at least at the margin), and document the variation of tax rates across sectors or regions, subject to different tax rules. But, while this approach can reveal incentives created by the tax system, it does not provide evidence on actual investment outcomes. Third, econometric techniques have been used to study the effects of certain tax incentives that are popular in advanced economies, such as R&D tax credits and special enterprise zones.[5] This literature has yielded interesting findings, but does not address the typical tax incentives that are found in developing countries, such as tax holidays. This paper aims to fill this gap and provide empirical evidence on tax incentives using a panel of developing countries.

Specifically, this paper will address two issues, beginning with the question of whether countries compete over tax incentives in the same way as over tax rates. The latter has been studied in a growing literature on fiscal reaction functions, which finds strong evidence on fiscal interdependence in corporate income tax (CIT) rates.[6] This paper confirms that such interdependence also exists in the sample of developing countries considered here, and then extends this approach to tax incentives, specifically tax holidays and investment allowances. It finds that tax holidays are subject to similar fiscal interdependence.

The second question addressed is whether the incentives employed have an impact on investment and economic growth. The existing empirical literature on the relationship between taxes and investment has generally found that while other factors are also (and sometimes more) important determinants of investment, taxes have significant effects.[7] This

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[2] Examples include Bird (2000), Shah (1995), OECD (2001), Zee, Stotsky and Ley (2002), and Klemm (2009).

[3] Examples include papers in Shah (1995) and Wells and Allen (2001).

[4] See again Shah (1995) for examples.

[5] On R&D tax credits, see for example: Bloom, Griffith and Van Reenen (2002). On enterprise zones see for examples: Chapter 4 of OECD (2001) and Bondonio and Greenbaum (2007).

[6] Examples include Devereux, Lockwood and Redoano (2008) and Altshuler and Goodspeed (2002).

[7] See surveys by Hassett and Hubbard (2002), Hines (1999) and De Mooij and Ederveen (2003).

paper confirms that the same is true for some incentives (tax holidays) on some types of investment (FDI). There is, however, no clear evidence of an effect on total private investment or economic growth.

These two questions are not only interesting in their own right, but also interrelated. The first question looks at the issue from the perspective of the country, while the second looks at it from the firms' angle. The finding that only those incentives that appear to be relevant for FDI are also used as a strategic tax competition tool, suggests that policy makers take firms' perspectives into account when reforming their tax systems. It also suggests that countries are indeed competing over footloose FDI, rather than just in a beauty contest over low tax rates.

The rest of the paper is structured as follows: Section II describes the data set collected for this study. Section III discusses the evidence on fiscal reaction functions for tax rates and tax incentives. Section IV considers the effect of tax instruments on FDI, gross private investment, and economic growth. Section V concludes.

II. Data

To address the research questions econometrically, we need to combine data on tax incentives and macroeconomic data. The latter are readily available, but data on tax incentives are difficult to collect. Information on tax incentives is typically contained in legislation and is not standardized. It is thus necessary to devise a way of summarizing the information in a few quantitative variables.

Our main source of corporate tax data are the Price Waterhouse worldwide summaries of corporate taxes, published between 1985 and 2004.[8] Because of our focus on developing countries, we extracted information for all African, Latin American and Caribbean countries, for which data are available for the majority of years (see Table A.1). This yields an initial unbalanced panel dataset of 47 countries over 20 years, but this is further reduced by the availability of macroeconomic data.

As to the precise variables, we focus on the most common incentives provided in the manufacturing and export sectors, which we consider to be the sectors most susceptible to tax competition. From those two we pick the most advantageous of the rules available, which can be justified by noting that they overlap and that treatment among them does not vary much. Table 1 lists the tax variables we construct, and the main underlying assumptions.

[8] Between 1999 and 2004, they were only published biannually. Since 2005 data are published online, with only the most recent year available.

Table 1. Tax Variables

Variable	Assumptions and Calculation
CIT rate	If multiple rates exist, the manufacturing rate for the most profitable firms is used.
Tax holidays	The longest available holiday of the manufacturing or export sector in years.
Investment allowance/tax credit	The most generous investment allowance of the manufacturing or export sector in percent of the investment. If a tax credit is offered, it is divided by the tax rate for comparability.

The macroeconomic data are from the IMF World Economic Outlook (WEO) and the World Bank World Development Indicators (WDI) databases. We collected data for the same 47 countries for which we have data on tax incentives. Given a 20-year period, that leaves us with a maximum of 940 observations per variable. As shown in Table 2, all variables are occasionally missing, except population.

We use two measures of investment: FDI and private gross fixed capital formation (for brevity "private investment" henceforth). The difference between them is that FDI includes takeovers, while private investment covers only new capital formation, but by all investors (domestic as well as foreign). We divide both by GDP to make them comparable across countries.

As control variables we use the rate of inflation, general government consumption expenditure, GDP, population size, and openness. For openness, we use a measure proposed by Squalli and Wilson (2006), which combines trade intensity and the relative importance of a country's trade level to total world trade to avoid biasing the measure upwards for small countries.[9] Descriptive statistics on these variables are also provided in Table 2.

[9] The measure is defined as: $\frac{n(X+M)_i^2}{GDP_i \sum_{j=1}^{n}(X+M)_j}$, where X and M are exports and imports of country i, and n is the number of countries in the world.

Table 2. Descriptive Statistics

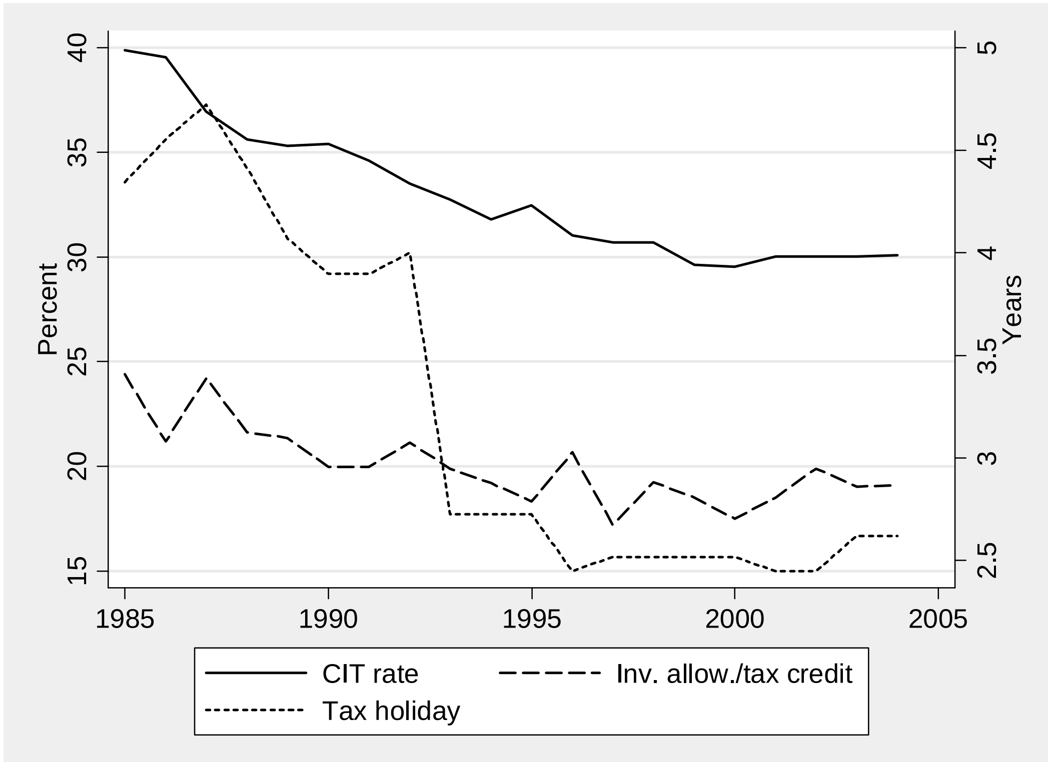
Variable	Unit	Mean	Std. Dev.	Min.	Max.	Obs.	Source
CIT rate	Percent	34.6	9.9	0.0	56	828	PWC
Tax holiday	Years	3.5	5.0	0.0	20	821	PWC
Inv. allow./tax credit	Percent	22.6	33.4	0.0	185.7	828	PWC
FDI	Percent of GDP	2.9	7.4	-82.9	90.7	910	WDI
Private Investment	Percent of GDP	14.3	6.6	0.0	50.2	864	WEO
Population	Millions	18.4	30.2	0.1	184.3	940	WEO
Openness (exports + imports / GDP)	Percent of GDP	74.0	41.0	12.1	250.0	925	WEO
Openness (Sqalli & Wilson, 2006)	Percent of GDP	20.0	52.5	0.9	571.2	925	WEO
GDP growth	Percent	3.0	6.4	-51.0	106.3	932	WDI
GDP per capita	1000s const. U.S. dollars	2.5	2.8	0.1	16.5	933	WDI
GDP	Bn. const. U.S. dollars	42.9	112.3	0.1	717.3	933	WDI
Gov. Consumption	Percent of GDP	14.6	5.7	2.9	43.5	901	WDI
Inflation	Percent	135.0	1152.0	-29.2	26762.0	932	WDI

Source: Authors' calculation based on Price Waterhouse Coopers (PWC); World Economic Outlook (WEO); and World Development Indicators (WDI) data.

Figure 1 provides an overview of the development of tax variables over the time period covered. It shows averages for the three tax variables, calculated from a perfectly balanced panel of 29 countries (see Table A.1), so that changes in the average reflect tax policy rather than changes in the composition of the data.[10] The figure reveals a downward trend in statutory CIT rates. It also shows that there was some base broadening in that tax holidays have become shorter and investment allowances smaller. Note that the value of the allowances to taxpayers has fallen even more, as this is obtained by multiplying the allowance with the tax rate. The combination of reductions in tax rates and base broadening is in line with developments in advanced economies, although base broadening mainly took the form of reduced depreciation allowances, given the lesser importance of tax incentives in those economies (see *inter alia* Devereux et al, 2002). The shorter average tax holidays may seem surprising, given recent evidence of further spreading of tax holidays in Sub-Saharan Africa (Keen and Mansour, 2008). A possible explanation for this may be that even though the number of tax holidays keeps increasing, their average length has shortened. Another complication is that some countries grant extensions of tax holidays, even if this is not envisaged by law, so that the reported limit may not always be binding.

[10] A chart based on the full set of unbalanced data reveals very similar patterns for tax rates and holidays, but marks a temporary increase in investment allowances between 1999 and 2002. This is caused by the addition of Mozambique in 1999, which has an enormous allowance of 186 percent of the investment until 2002.

Figure 1. Average Tax Rates and Incentives Over the Years



Source: Authors' calculation based on PWC data.

Notes: Unweighted averages over a fully balanced panel of 29 countries.

III. EMPIRICAL EVIDENCE ON TAX COMPETITION

A. Methodology

A small, but growing, literature investigates fiscal interactions directly, by estimating reaction functions on tax rates or public expenditure. Such reaction functions are usually specified as the regression of one country's tax rate on the average rate of its competitors. Brueckner (2003) surveys this literature and discusses the main theoretical issues and econometric challenges. The main theoretical question in such models is how to interpret the result, given that a number of different models lead to the same specification.

The main empirical challenge is the endogeneity of the principal regressor, because this is made up of the regressands of other countries. This problem can be addressed either by employing instrumental variable regressions or maximum likelihood estimators. Our results will be based on the maximum likelihood estimator that corrects for the endogeneity related to the spatial dependency by introducing a Jacobian term to the Likelihood function

(Anselin 1988). We prefer this methodology in this paper, because we do not dispose of enough relevant and exogenous instruments for the spatially lagged variable.[11]

Recent examples of attempts to estimate reaction functions for CIT rates in developed countries include Devereux et al. (2008) and Altshuler and Goodspeed (2002). In this paper, we wish to extend this to developing countries and to tax incentives.

Specification

Our specification assumes a contemporaneous reaction to other countries' choices, and allows for dependence on a few control variables. Given that tax reforms are typically pre-announced, this contemporaneous specification remains valid, even if countries need some time to implement reforms. Such model is also known as a spatial lag model. To allow for unexplained heterogeneity across countries, we specify such a model with fixed country effects:

$$y_{it} = \rho(W_{NT}y)_{it} + X_{it}\beta + \eta_i + \varepsilon_{it} \qquad (1)$$

where y is the tax variable (CIT rate or a tax incentive) and Wy is the spatial lag of variable y, with W the weighting matrix.[12] Coefficient ρ is the interaction coefficient. X is a vector of control variables, with coefficient vector β, η are country fixed effects and ε is an independently and identically distributed error term. Subscripts i and t indicate the country and time period, with N and T the total number of countries and time periods.[13]

A crucial decision concerns the choice of weights. A common assumption is that geographically close countries interact more strongly, which can be implemented by using inverse distances as weights. An alternative is to use a contingency weight matrix, which gives a weight of 1 to all neighbors and zero weights otherwise. We do not employ this second approach, because (1) competition for capital is likely to go beyond first order

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[11] The approach of using the weighted average of the control variables of other countries often yields invalid instrument sets (although assiduous trial and error can lead to a set of instruments that passes standard specification tests).

[12] Specifically, this weight matrix is the result of the Kronecker product $W \otimes I_T$, where I_T, is the identity matrix with rank T and W is the NxN spatial weight matrix.

[13] While we estimate equation (1) independently for each tax variable of interest, one could argue that these three tax variables are set simultaneously and jointly by governments. A country could react to a change of one of the tax variables in another country by adjusting any of its tax instruments. As a result, ideally, one would estimate the interaction functions of the different tax variables at the same time with each reaction function including the other tax variables as explanatory variables. Unfortunately, this approach would go beyond what is currently econometrically feasible. Kelejian and Prucha (2004) developed an estimator for cross-sectional data, but to the best of our knowledge, no methodology for simultaneous systems of spatially interrelated panel equations has been developed. We therefore have no choice, but—like the other papers in this literature—to rely on the existing spatial econometric techniques and estimate the reaction functions separately. Future research on tax reactions could be refined in line with econometric progress.

neighbors and (2) our dataset is incomplete, which would leave some countries with few or no neighbors.

As control variables we include GDP per capita, population, openness, and general government consumption expenditure as a percentage of GDP. GDP per capita serves as a measure of the income level, as higher income is generally related to stronger demand for public services. GDP per capita, in combination with population, also proxy for agglomeration rents that could be taxed by the government (see Baldwin and Krugman, 2004), as well as for size, as larger countries are under less pressure form tax competition (inter alia Bucovetsky, 1991). Openness points to the exposure of a country to trade and competition for capital. As explained above, we use an openness measure that is not biased towards greater openness for small countries. Finally, government consumption is included to control for preference for public goods and the government's revenue requirement. To alleviate possible endogeneity, we lag this by one period.

Estimation

Checking econometrically for spatial interaction on tax variables is achieved by testing the null-hypothesis H_0: $\rho = 0$. The estimated coefficient should be smaller than one, as the interaction game would otherwise be explosive. But before running this test, a few econometric issues need to be addressed to ensure an unbiased estimation of this equation.

Endogeneity of spatial interaction term

The most important concern is the obvious endogeneity of the spatially lagged tax variable, as countries influence each other's tax policies reciprocally. It is well known (Anselin, 1988) that estimating the spatial lag and spatial error model by OLS leads to biased results. As a solution Elhorst (2003), based on Anselin (1988), proposes maximum likelihood estimators for spatial lag and spatial error models in the context of panel data. This works by first writing the model in deviations from means to remove the fixed effects and then maximizing the following likelihood function for the spatial lag model:

$$\begin{aligned} & -\frac{NT*}{2}\ln(2\pi\sigma_\varepsilon^2)+\ln\left|I_{NT*}-\rho W_{NT*}\right|-\frac{1}{2\sigma_\varepsilon^2}e'e, \\ & e=(I_{NT*}-\rho W_{NT*})y*-X*_{it}\,\beta \end{aligned} \qquad (2)$$

where * indicates deviations from means (and in the case of *NT* the fact that the sample size is reduced by missing observations among the control variables).

Choice between different spatial interactions

The presence of an interaction term can be explained by various models. The empirical specification above would be appropriate both for a model in which countries mimic their tax rate for political reasons (yardstick competition) and models in which countries compete for mobile capital (resource-flow model). While both interpretations could lead to quite different policy lessons, they do not affect the appropriate estimation method. There is, however, another possibility: instead of the variables, the unobservables could be spatially correlated.[14] For example, some political or economic variables (such as political or financial stability) that vary over time could spill over or affect a region encompassing neighboring countries. This would entail spatial autocorrelation in the error term, but no interaction. Because of this concern we also estimate the spatial error model of the form:

$$\begin{aligned} y_{it} &= X_{it}\beta + \eta_i + \varepsilon_{it} \\ \varepsilon_{it} &= \lambda (W_{NT}\varepsilon)_{it} + \upsilon_{it} \end{aligned} \tag{3}$$

where λ is the spatial error correlation coefficient and υ_{it} is an independently and identically-distributed shock. As in the case of the spatial lag model, a maximum likelihood estimator is needed to estimate this model.[15]

Anselin et al. (1996) developed a robust Lagrange Multiplier (LM) test for the choice between spatial autocorrelation and spatial lag dependency. It is robust, because it tests for spatial autocorrelation in the presence of a spatially lagged variable, and for spatial lag dependence in the presence of spatial error autocorrelation. We therefore estimate both models for each variable of interest and report the test results, which consistently indicate a preference for the spatial lag model (see below).

Missing observations

Unfortunately our data set is not complete. While missing observations typically do not cause major problems beyond the reduction of the sample size, an unbalanced panel is of greater concern in reaction functions as specified above. This is because an unbalanced panel would cause the main regressor, i.e., the average of tax variables in other countries, to vary from year to year because of a changing sample composition. To avoid this problem, we calculate the weighted averages only on a panel that is fully balanced in terms of the tax variables, thus ensuring that all variability in the weighted average is the result of tax policy, not sample composition. In some cases, however, it is not the tax but a control variable that is missing. In these cases we only drop that observation, after having calculated the weighted average of

[14] Manski (1993) distinguishes in this context between endogenous (behavioral) and exogenous (contextual) interaction effects. The former results from reciprocal influences of peers. The latter refers to measures of peers that are unaffected by their current behavior. Manski (1993) points to the identification difficulties of both interaction effects, also known as the reflection problem.

[15] After transforming into deviations from means, the likelihood function to be maximized is:

$$-\frac{NT^*}{2}\ln(2\pi\sigma_\upsilon^2) + \ln\left|I_{NT^*} - \lambda W_{NT^*}\right| - \frac{1}{2\sigma_\upsilon^2}u'u \,,\; u = (I_{NT^*} - \lambda W_{NT^*})(y^* - X^*_{it}\,\beta)\,.$$

the tax variables. Our resulting panel is thus not fully balanced, but the calculated tax averages are based on a balanced panel.[16]

Given the different availability across countries and years, our aim is to use the largest possible balanced panel (on tax variables). The data offer two relatively large balanced data subsets: 38 countries over 11 years (1988–98) or 37 countries for 12 years (1991–2002). Given our particular interest in spatial interaction, our main results are based on the first set, which has more countries. As a robustness check, we also ran the same regressions on the second set and obtained similar results (see footnote 17).

Time effects

In principle we would also like to include time dummies to control for shocks in each year that are common to all countries. However, given our assumption that competition, although declining over distance, exists across all countries rather than only across neighbors, adding time dummies would not be meaningful: within a year, the average of all other countries' tax rates will necessarily be the highest for the country with the lowest tax rate and vice versa. This trivial relationship between the average of all countries and the excluded country is clearly not of interest.

Moreover, if time dummies are added, this is equivalent to including the average tax of all countries. As a result one would estimate the following equation:

$$tax_{it} = \rho Wtax_{it} + t\bar{a}x_t + X\beta + \varepsilon \tag{4}$$

with tax_{it} the tax rate of country *i* in year *t*; and $Wtax_{it}$ the weighted average of all countries except *i* in year *t* and $t\bar{a}x_t$ the average of all countries in year *t*. Obviously, $Wtax_{it}$ and $t\bar{a}x_t$ are highly correlated, the only difference being the exclusion of country *i* in the former. It is thus hard to identify the true impact of each variable, because of multicollinearity.

Depending on the chosen weight matrix, these problems can be reduced, but not completely avoided. Instead we therefore add a time trend, to control for some common time effects.

B. Results

Our first set of results demonstrates the importance of using the correct econometric technique for specifications including a spatial term (Table 3). We illustrate the differences among them both for the CIT rate (columns 1 to 3) and years of tax holidays (columns 4 to 6). All estimation results are based on models transformed into deviations from means within groups and use the inverse distance weight matrix—the OLS regression is thus equivalent to a fixed effect regression on the untransformed data.

[16] We used a method based on Baltagi et al. (2007) to transform the unbalanced panel correctly into deviation from means form.

The OLS regressions show strong fiscal interdependence, but for econometric reasons, these results are subject to bias. The maximum likelihood estimates of the interaction coefficient are much lower, revealing an upward bias in the OLS result. As both the spatial lag and the spatial autocorrelation coefficients are positive and significant, both models seem to fit the data, and the choice between them should be made on the basis of a robust LM test.

Test statistics for the robust LM tests are shown in columns (1) and (4). For the CIT rate equation the result is very clear. The robust LM error test does not reject the null hypothesis of no spatial autocorrelation, while the null of absence of spatial lag dependency is rejected at the 1 percent level by the robust LM lag test. This evidence clearly points to the spatial lag model as the correct one. For the tax holiday equation, the tests admit the presence of spatial autocorrelation and spatial lag dependency at the same time. In that case, Anselin and Rey (1991) and Anselin and Florax (1995) have found, based on Monte Carlo simulations, that the larger of the two statistics indicates the correct model, which again suggests that the spatial lag model should be chosen over the spatial error model. This choice is also supported by the higher likelihood ratios for the spatial lag model.

Table 3. The Choice Between Estimation Methods

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Var.	CIT rate	CIT rate	CIT rate	Holiday	Holiday	Holiday
Estimation Method [1]	OLS	MLSL	MLSE	OLS	MLSL	MLSE
Wy (ρ)	0.395***	0.277***		0.619***	0.363***	
	(0.111)	(0.096)		(0.135)	(0.100)	
Wε (λ)			0.246**			0.388***
			(0.112)			(0.097)
GDP per capita	-1.108	-1.429*	-1.808**	-0.242	-0.554	-0.305
	(0.882)	(0.851)	(0.898)	(0.552)	(0.526)	(0.593)
Population	-0.586***	-0.634***	-0.676***	0.070	0.036	0.060
	(0.110)	(0.104)	(0.105)	(0.066)	(0.064)	(0.068)
Openness	0.510	0.518	0.536	-0.541	-0.716	-0.624
	(1.110)	(1.105)	(1.114)	(0.708)	(0.701)	(0.702)
Gov. consumption	0.328***	0.346***	0.359***	0.057	0.078	0.047
Expenditure	(0.082)	(0.080)	(0.081)	(0.054)	(0.053)	(0.053)
LM error test (λ)	4.296			26.207		
LM lag test (ρ) [2]	13.166			33.536		
Observations	404	404	404	397	397	397
Likelihood		-1017.6	-1020.2		-820.1	-821.1

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

[1] OLS: Ordinary least squares; MLSL: Maxmimum likelihood, spacial lag model; MLSE: Maximum likelihood, spacial error model.

[2] The LM tests are distributed $\chi2(df=2)$ with critical levels of 4.60 (p=0.1), 5.99 (p=0.05) and 9.21 (p=0.01)

Having established a preference for the spatial lag model, the following table will present more results using that model. Table 4 shows results for all three tax instruments, both with and without a time trend. The results without a time trend (columns 1, 3, 5) indicate the presence of spatial interaction on the CIT rate and the tax holiday, but not on the investment allowance. Specifically, a country reacts to a 10 percentage point drop of the average CIT rate of other countries, by lowering its own rate by 2.77 percentage points. It reacts to a decline of the average tax holiday of one year, by reducing its own holiday by just over 4 months (0.36 years). The long-run impact—although not detectable with this specification—may of course be higher.

The results with a time trend (regressions 2, 4, 6) differ markedly, suggesting that identifying a reaction coefficient in addition to a common time trend is difficult. The CIT rate and the tax holiday are characterized by a declining trend, suggesting that countries are more and more trying to attract corporate income by cutting general tax rates rather than with specific incentives. Including the time trend has serious repercussions on the spatial interaction coefficient for the CIT and the tax holiday, which become insignificant.

Table 4. Fiscal Interactions for Different Tax Instruments

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Var y:	CIT rate	CIT rate	Holiday	Holiday	Inv. allow.	Inv. allow.
Wy (ρ)	0.277***	-0.147	0.363***	0.110	0.110	-0.052
	(0.096)	(0.138)	(0.100)	(0.123)	(0.116)	(0.130)
GDP per capita	-1.429*	0.560	-0.554	0.802	-0.002	0.118***
	(0.851)	(0.954)	(0.526)	(0.602)	(0.028)	(0.031)
Population	-0.634***	-0.442***	0.036	0.198***	0.027***	0.041***
	(0.104)	(0.114)	(0.064)	(0.072)	(0.003)	(0.004)
Openness	0.518	0.683	-0.716	-0.815	-0.070*	-0.068*
	(1.105)	(1.085)	(0.701)	(0.686)	(0.037)	(0.035)
Gov. consumption	0.346***	0.285***	0.078	0.036	0.004	0.000
Expenditure	(0.080)	(0.081)	(0.053)	(0.053)	(0.003)	(0.003)
Time trend		-0.589***		-0.319***		-0.023***
		(0.131)		(0.067)		(0.003)
Observations	404	404	397	397	404	404
Likelihood	-1017.58	-1008.98	-820.131	-809.641	350.6247	377.15857

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.
Estimation method: Maximum likelihood on a spatial lag model.

Regarding the control variables, results are not fully consistent across specifications, but suggest that as countries become richer they use lower tax rates and more generous allowances. There is no evidence of countries taxing increasing agglomeration rents, as growing populations lead to lower CIT rates, and more generous incentives. The variation in openness within one country also does not seem to drive the tax variables, except that the investment allowances are slightly lower in more open economies. An increase in the government's spending requirement leads to higher tax rates, implying that for this set of countries, the CIT is an important revenue-raiser at the margin.

Overall, the results are, unfortunately, not unambiguous. We find strong interaction for tax rates and holidays, but cannot discriminate between this and a general time trend. One possible interpretation would be that all countries have been reducing tax rates, and that this general direction of tax reform, rather than strategic interaction, drives the results. On the other hand, it is also possible that the negative time trend is entirely driven by tax competition and that the regularity of fiscal reactions makes it difficult to identify a reaction term separately. Or, stated econometrically, our weight matrix and time trend are interrelated by construction. In our inverse-distance weight matrix we assume that all countries compete with all other countries. At the same time, the time trend is the same for all countries. As a result it is hard to distinguish the weighted average of CIT rate for all countries from the time trend of CIT rate for all countries. Hence, the disappearance of the interaction coefficient in the regressions including a time trend does not necessarily imply the absence of strategic interaction.

Summing up the results from the regressions on fiscal interactions, we conclude that the empirical evidence on developing countries provided some evidence on competition over tax rates and holidays, but not investment allowances.[17] We cannot conclude however which interaction mechanism underlies it. As mentioned above, there are two main candidates as explanations for spatial interaction: a spillover or a resource-flow model (see discussion in Brueckner, 2003). In the context of our research, the spillover model could mean that a country's government takes the other governments' tax policy as a yardstick to judge its own policy (as in the yardstick competition model of Besley and Case, 1995). The resource flow model, on the other hand, predicts that governments strategically interact to attract resources, such as mobile capital. While the evidence on spatial interaction cannot help in discrimination between these models, the following section, which addresses the effect of the three tax instruments on investment and growth, sheds further light on this, although that is not its only or main purpose. Finally, apart from the two possible interaction mechanisms, the observed developments could also be the results of a common trend, and, unfortunately, it is difficult to discriminate between this and the other explanations.

IV. Empirical Evidence on The Effect on Investment and Growth

We now turn to the question of the extent to which the CIT rate and tax incentives are effective in raising investment. This question certainly has its own interest but is also relevant with respect to the interpretation of the tax interaction results obtained in the previous section. If we find that investment is affected by the CIT rate or tax holidays, where

[17] We repeated the regressions of Tables 3 to 4 with the other balanced data subset. This gave qualitatively the same results, except for the investment allowance, where the interaction turned out negative and significant. While we cannot explain this result, it certainly does not point to any competition on investment allowances.

we also found evidence of strategic interaction, then this points towards a resource flow model interpretation of the results.

A. Methodology

Specification

To test for the impact of tax instruments on investment and growth, we specify a simple dynamic panel model of the following form:

$$Inv_{it} = \delta Inv_{i,t-1} + Tax_{it}\gamma + X_{it}\beta + \mu_t + \eta_i + \varepsilon_{it} \qquad (5)$$

where *Inv* is the investment (or growth) variable, *Tax* a vector of the tax instruments (made up of some or all of the *y* above), μ are time effects and all other items are as before.

Note that we systematically control for country and year effects. The inclusion of year effects does not pose the problem encountered in the spatial reaction model above.

The dependent variable

We consider two investment variables, FDI and total private investment. In both cases, we divide it by GDP for comparability across countries. As noted above (section II), these variables cover different, but overlapping, types of investment. The regressions on FDI are of obvious interest, given that tax incentives are often tied to FDI or at least presented as measures to boost FDI. Still the ultimate policy goal of a country is likely to be an increase in the capital stock, which justifies a look at total investment. Finally, even if total investment is unchanged, FDI could be beneficial, if it replaces less productive local capital by more productive foreign-owned capital, and/or if there are spillovers to other sectors of the economy. We therefore also consider the effect of tax policy on economic growth.

Unfortunately we do not have disaggregated investment data, such as a breakdown of FDI into real and financial flows, or breakdown by sector or source country. A distinction between real and financial investment component of FDI would allow us to see how differently the components react to our tax variables, which could be interesting, given that many of the investment allowances and tax credit incentives are designed for investment in property, plant and equipment. Distinguishing between different sectors (as in Swenson, 1994) would have made it easier to identify the impact of incentives targeted at particular sectors. The use of aggregate investment data rather than bilateral investment flows makes it impossible to account for some important home country effects, such as relative tax rates and double taxation regimes. All of these issues remain to be explored in future research.

Explanatory variables

Apart from a lagged dependent variable, which allows for persistence of investment and reduces autocorrelation in the residuals, we add a vector of tax variables, and controls. The tax variables are the same as in the previous section. Other investment studies sometimes use effective (average or marginal) tax rates, rather than the statutory rate presented here. We do not follow this approach, because we do not have the detailed depreciation data necessary to calculate effective tax rates for our large sample of countries. Moreover, by considering variables on tax holidays and investment allowances, we have also allowed to some extent for differences in the tax base, just that we cover them in separate variables, rather than one combined measure.

The three tax variables interact with each other, as, for example, the value of investment allowances would be reduced to nil in the presence of tax holidays. Therefore, the specification should arguable not only include the three tax instruments, but also their interactions. When experimenting, however, it turned out that interactions were never significant and, moreover, that their inclusion did not affect coefficients. We therefore dropped them from our specification.

Drawing on the existing empirical literature, we also add a set of control variables. To capture the market potential of a country we include the country's GDP in US dollars at constant prices. We also include GDP per capita as a proxy for productivity and wage rates, and inflation rate as a measure of macroeconomic stability. We also add the adjusted openness measure and control for the marginal benefits of public goods to investors, by including the general government's consumption expenditure as in percent of GDP. We would also have liked to add controls for other time-varying country differences, such as infrastructure, but we could not find sufficiently complete data.

To allow for some delay between investment decisions and implementations, we lag all explanatory (tax and control) variables by one year.

Estimation

As is well known, the inclusion of a lagged dependent variable in panel data leads to biased results if OLS (upward bias) or fixed effect estimators (downward bias, see Nickell, 1981) are used. To solve this, Arellano and Bond (1991) developed an estimator, referred to as "difference GMM," by taking the first differenced model to remove fixed effects and then using all valid lags of the untransformed (i.e., not differenced) variables as instruments. Blundell and Bond (1998), however, have pointed to the possible weak instruments problem of the difference GMM estimator because of the possible lack of correlation between the instruments and the regressors in the model once it has been first-differenced.[18] Therefore, we also use the "system GMM" estimator suggested by Blundell and Bond (1998). In addition to using lagged levels to instrument current differences (as in difference GMM), this approach also uses lagged first differences to instruments levels. Blundell and Bond (1998) provide Monte Carlo simulation results showing that this procedure leads to a more efficient and robust estimator.

[18] Another weakness of the difference approach is that it magnifies gaps in unbalanced panels (as remarked by Roodman, 2006), which is the case in our sample.

We estimated our model with OLS, within groups, difference GMM and system GMM and found, as predicted by theory, that the system GMM estimator outperforms the difference GMM estimator. Only the system GMM estimator of the lagged dependent variable is consistently within the predicted bounds of the OLS and within-groups estimators.

The GMM estimators are consistent for panel data as the number of groups (i.e., here countries) goes to infinity. They are therefore the estimators of choice for wide panels (i.e., large N and small T). For long panels (i.e., small N and large T), however, the within-group estimator may be a better choice, because its bias decreases as more periods are added (Nickel, 1981). Moreover, the within-groups estimator tends to have a relatively small variance, especially compared to consistent GMM-type estimators (Harris et al., 2008). Furthermore, Judson and Owen (1999) show that the biases of within-groups estimates of coefficients on variables other than the lagged dependent variable are relatively small. For all these reasons, and considering that our dataset is neither particularly wide nor long, we consistently present both the within-groups and system GMM estimation results.

Data

We use the same data set as above, but because a perfectly balanced panel is not required for this specification, we can use a much larger sample. We drop Bolivia and Venezuela, because their investment pattern seems to be determined mostly by the extractive industries sectors.[19] All other countries are included in principle, although for lack of macroeconomic data all regressions excluded Liberia, regressions on FDI exclude additionally Namibia, and regressions of private investment exclude the Bahamas and Jamaica, but include Namibia.

B. Results

Our first set of results (Table 5) explores four different estimation techniques for equation (5) using FDI as the dependent variable: (1) OLS, (2) within-groups (fixed effect), (3) difference GMM and (4) system GMM. For the choice of our estimation technique we are particularly interested in the estimated coefficient of the lagged dependent variable. All four techniques suggest, as expected, a significantly positive relationship to past FDI. According to econometric theory OLS should yield an overestimate of the coefficient, while within-groups should yield an underestimate. These two regressions thus suggest a true value for the coefficient on lagged FDI in the range of 0.35 to 0.64. The difference GMM estimator, although theoretically consistent, turns out to behave poorly in this sample, with the estimated coefficient even below the underestimated within-groups estimate. The system GMM estimate, however, which uses more information, outperforms difference GMM and yields an estimated coefficient within the expected range. Moreover, the Sargan/Hansen test of overidentifying restrictions does not reject the chosen instrument set. For these reasons we will from now on focus on the system GMM results, although we keep reporting the within-groups results, for the reasons given above.

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[19] Nigeria is also a major oil producer, but results are unaffected by its inclusion, so we do not drop it.

Table 5. The Choice of Estimation Method

	(1)	(2)	(3)	(4)
Dependent Variable	FDI	FDI	FDI	FDI
Estimation Method	OLS	Within groups	Diff. GMM	Syst. GMM
FDI_{t-1}	0.644***	0.353***	0.220***	0.488***
	(0.05)	(0.06)	(0.07)	(0.07)
CIT rate	-0.045***	-0.033*	-0.060**	-0.045***
	(0.01)	(0.02)	(0.03)	(0.02)
Holiday	0.069***	0.001	0.081**	0.102***
	(0.02)	(0.02)	(0.04)	(0.03)
Inv. allowance	-0.292	-0.227	0.044	-0.380
	(0.22)	(0.37)	(0.56)	(0.40)
GDP	-0.001*	0.007	0.025	-0.001
	(0.00)	(0.00)	(0.02)	(0.00)
GDP per capita	0.038	-0.170	-1.253	0.058
	(0.05)	(0.25)	(0.76)	(0.09)
Inflation	0.000	0.000	0.000***	0.000***
	(0.00)	(0.00)	(0.00)	(0.00)
Openness	0.259**	-0.158	0.527	0.215
	(0.12)	(0.15)	(0.54)	(0.17)
Gov. consumption	0.010	-0.040	0.012	0.020
expenditure	(0.02)	(0.03)	(0.10)	(0.03)
Constant	2.140***			2.583***
	(0.55)			(0.75)
Observations	700	700	651	700
Number of countries	43	43	43	43
R-squared	0.50	0.28		
Hansen J test			19.19	12.70
P-value			1.000	1.000

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Regarding the tax variables, we find that the CIT rate has a negative and significant impact on FDI irrespective of estimation technique (even under OLS and difference GMM). This result is in line with theory and previous empirical results showing a negative relationship between investment and the after tax cost of capital (see, *inter alia*, Hasset and Hubbard, 2002). Our results indicate that a 10 percentage point increase of the CIT rate lowers FDI by between 0.33 percentage points of GDP (within groups) and 0.45 percent points of GDP (system GMM). For the tax incentive variables, the same investment theory would predict a positive impact of tax holidays and investment allowances and tax credits. The tax holiday indeed enters the equation significantly, except when using the within-groups estimator. The system GMM results imply that adding ten years of tax holidays increases FDI by about 1 percent of GDP. Since the within-groups estimator is not significant, we conclude that it is the variation across countries that accounts for this effect and not the one within a country. Investment allowances or investment tax credits, on the other hand, do not explain any of the variation in FDI.[20]

Regarding the control variables, we observe that the market size effect, proxied by GDP only enters significantly in the OLS estimation, and yields an unexpected negative sign. Further we find a positive impact of inflation on FDI relative to GDP. While we cannot explain it, the effect is economically insignificant. Finally, within a country, rising government consumption expenditure does not seem to attract FDI, which could suggest that public expenditure is used for spending that does not benefit investors.

In Table 6 we expand the analysis to cover the impact on total private investment (as a share of GDP) and real economic growth.[21] For easy comparisons, the first two columns repeat the within-groups and system GMM estimates for FDI from Table 5.

On total private investment we find again that the lagged dependent variable is very informative about current levels. With respect to the tax policy variables, however, we find a different picture. The CIT rate seems to have a significantly positive impact on private fixed capital formation, but this is not robust across estimation techniques. Using the more appropriate system GMM the impact of the CIT rate disappears. Unlike in the FDI case, the tax holiday is consistently insignificant. The investment allowance also remains insignificant.

When considering the regressions with real economic growth as the dependent variable, we consistently find that most tax variables are insignificant, with the exception of negative effect from increasing the CIT rate. Given the limited effect of taxes on total private investment, this is not particularly surprising, although a positive effect on growth would be possible even for an unchanged total capital stock, for example, if taxes affect the composition of the capital stock.

The finding that the CIT rate and tax holidays affect FDI, but not (or not robustly) total private investment or real economic growth calls for an explanation. A few candidates include the following: First, remembering the differences in the definition of FDI and private investment, it could be that these two tax instruments affect the part of FDI that is not included in investment, notably mergers and acquisitions. If this is the reason for the finding, then it would appear that the tax system mainly affects the ownership rather then amount of capital in an economy. Second, it is possible that higher FDI crowds out domestically-financed investment, with no net effect.

Moreover, the absence of an effect on economic growth from tax incentives suggests that the increased foreign ownership of assets (whether achieved through acquisitions or by crowding

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[20] We also ran regressions with both tax incentive variables and an interaction term of both tax incentive variables. Again this did not help explaining the variance of FDI.

[21] While OLS and difference GMM results are not shown, it remains the case that system (but not difference) GMM estimates of the lagged dependent variable were between the within-groups and OLS bounds.

out domestic investment through FDI) does not appear to have beneficial spillover effects that are strong enough to have an impact on growth. This is indeed in line with the findings of the literature that a positive impact of FDI on economic growth is conditional on key financial and institutional aspects of absorptive capacity in host countries (Durham 2004, Borensztein, et al. 1998).

Table 6. The Effect of Tax Instruments on Investment and Growth

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	FDI	FDI	Private Investment	Private Investment	Growth	Growth
Estimation method	Within groups	System GMM	Within groups	System GMM	Within groups	System GMM
Lagged. Dep. Var.	0.353***	0.488***	0.558***	0.634***	0.208**	0.244**
	(0.060)	(0.065)	(0.066)	(0.074)	(0.087)	(0.095)
CIT	-0.033*	-0.045***	0.056*	0.014	-0.020	-0.064*
	(0.017)	(0.016)	(0.029)	(0.032)	(0.049)	(0.032)
Holiday	0.001	0.102***	-0.054	0.083	-0.042	0.021
	(0.020)	(0.034)	(0.037)	(0.051)	(0.054)	(0.038)
Inv. allowance	-0.227	-0.380	-0.258	-0.699	0.513	-0.292
	(0.369)	(0.404)	(0.309)	(0.456)	(0.707)	(0.590)
GDP	0.007	-0.001	-0.005	0.001	-0.024**	-0.004***
	(0.004)	(0.001)	(0.009)	(0.002)	(0.011)	(0.001)
GDP per capita	-0.170	0.058	0.041	0.240	-2.521***	-0.106
	(0.248)	(0.086)	(0.368)	(0.211)	(0.769)	(0.078)
Inflation	0.000	0.000***	-0.000***	-0.000***	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Openness	-0.158	0.215	0.520*	-0.004	1.753***	0.666***
	(0.152)	(0.174)	(0.297)	(0.285)	(0.314)	(0.233)
Gov. consumption	-0.040	0.020	-0.124*	-0.060	-0.083	0.022
expenditure	(0.030)	(0.034)	(0.066)	(0.047)	(0.069)	(0.053)
Constant		2.583***		5.232***		0.244**
		(0.754)		(1.657)		(1.229)
Observations	700	700	675	675	716	716
Number of countries	43	43	42	42	44	44
R-squared	0.28	.	0.37	.	0.18	.
Hansen J test		12.70		18.81		13.17
P-value		1.000		1.000		1.000

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

V. CONCLUSION

This paper has tackled a number of separate, but related questions. We have shown that strategic interaction over taxes is not restricted to tax rates, but is equally present on tax incentives, notably tax holidays. This is not to say that countries compete over every aspect of their tax systems, as there is no evidence on interactions on investment allowances. We have also shown that tax holidays, just like tax rates, do appear to affect FDI, while investment allowances do not. In combination with the findings on tax reactions, this suggests that countries compete only over tax instruments that also affect FDI. This can be interpreted as evidence—though clearly not proof—of the resource-flow model of fiscal interactions, as opposed to pure tax mimicking, which would cover all taxes. The possibility of countries simply following similar trends in their tax policy also remains a possibility that cannot be ruled out.

The finding that tax holidays are used as tool of tax competition and affect FDI, while investment allowances do not seem to play a role in either case is interesting. A possible explanation of this finding is that a country may be trying (successfully) to compete for rent-earning FDI, because very profitable investments would benefit far more from a tax holiday than from an allowance, which would only be worth a small share of the rent. This could also explain countries' reluctance to move away from tax holidays, and to offer instead investment allowances or accelerated depreciation as often advised by economists. Given that there are strong arguments against tax holidays, policy advisers should consider recommending other alternatives than investment allowances, e.g., reduced tax rates, which would also be valuable for highly-profitable investment.[22]

Moreover, we made the interesting observation that the effect of tax rates and tax holidays on FDI, does not imply that there is an effect on total investment or economic growth. This suggests either crowding out, or, that especially the part of FDI, which concerns transfer of ownership rather than green field investment, is affected.

These results will hopefully add to the debate about tax incentives. They suggest at the same time that tax incentives may work, as there clearly is a measurable effect on FDI, but also that their ultimate benefits for the economy may be limited.

While the previous literature has mainly focused on case studies or evidence that focused on incentives used mainly in developed countries, such as R&D tax credits, this study provides the first econometric panel analysis of tax incentives in developing countries. It will hopefully not be the last, as a number of interesting extensions would merit further research. Notably, the analysis should be extended to Asia, as incentives are also rampant in that region. Moreover, it could be interesting to distinguish by sectors and, for FDI, by source country, provided the necessary data can be collected.

[22] For more details on this argument and related issues, see Klemm (2009).

APPENDIX

Countries and Periods Covered in the Corporate Tax Dataset.

	Africa	Period 1/	Latin America	Period[1]	Caribbean	Period[1]
1.	Botswana	all	Argentina	All	Antigua and Barbuda	all
2.	Cameroon	88-02	Bolivia	All	Bahamas	all
3.	Congo, Rep.	88-00	Brazil	All	Barbados	all
4.	Gabon	88-98, 01-02	Chile	All	Dominican Republic	all
5.	Ghana	91-04	Colombia	All	Jamaica	all
6.	Ivory coast	all	Costa Rica	All	St. Lucia	all
7.	Kenya	all	Ecuador	All	Trinidad and Tobago	all
8.	Liberia	85-91	El Salvador	85-98		
9.	Malawi	85-02	Guatemala	All		
10.	Morocco	all	Guyana	88-04		
11.	Mauritius	all	Honduras	85-98		
12.	Mozambique	99-04	Mexico	All		
13.	Namibia	91-04	Nicaragua	85-86,92-97,01-02		
14.	Nigeria	84-02	Panama	All		
15.	Senegal	85-02	Paraguay	All		
16.	South Africa	All	Peru	All		
17.	Swaziland	91-96,01-04	Uruguay	All		
18.	Tanzania	88-04	Venezuela	All		
19.	Uganda	91-04				
20.	Dem. Rep. of Congo	85-96, 01-04				
21.	Zambia	all				
22.	Zimbabwe	all				

Source: Authors' calculation based mostly on data in Price Waterhouse Coopers (various years).

1/ "All" indicates 1985–2004.

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