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## Base Erosion, Profit Shifting and Developing Countries

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# Base Erosion, Profit Shifting and Developing Countries[1]

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## Abstract

International corporate tax issues are prominent in public debate, notably with the G20-OECD project addressing Base Erosion and Profit Shifting ('BEPS'). But while there is considerable empirical evidence for advanced countries on the cross-country fiscal externalities at the heart of these issues, there is almost none for developing countries. This paper uses panel data for 173 countries over 33 years to explore their magnitude and nature, focusing particularly on developing countries and applying a new method to distinguish between spillover effects through real decisions and through avoidance —and quantify the revenue impact of the latter. The results suggest that spillover effects on the tax base are if anything a greater concern for developing countries than for advanced—and a significant one.

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## I. INTRODUCTION

International aspects of corporate taxation have recently come to prominence in public debate, prompted largely by increased awareness of the relatively low amounts of tax that, as a result of cross-border tax planning, many multinational enterprises pay. The issue itself, of course, is not new. What is new is the attention it is receiving from policy makers. Most notably, the G20-OECD project (OECD, 2013) on base erosion and profit shifting ('BEPS'), envisaging action in fifteen areas, is an unparalleled effort to strengthen the international corporate tax system by limiting opportunities for avoidance by multinationals. More broadly too there is an increased awareness of the intensity of international tax competition, and the possibility of mutual harm from the attempts of each country to make its tax system more attractive than those of others.

These concerns with current international corporate tax arrangements have arisen most prominently in advanced economies. And it is they that drive the BEPS process.[2] Clearly, however, these concerns may be ones for developing countries too. There is substantial experience, for instance, of even single international tax cases involving what are for these countries very significant amounts of revenue (IMF, 2014).[3] And indeed developing countries tend to be more reliant on the corporate income tax as a share of all tax revenue than are higher income countries, as Figure 1 shows, and with fewer realistic alternative sources of revenue. All this suggest that developing countries may well be more vulnerable to erosion of the corporate tax base. There has been, however, no broad empirical assessment of the significance of these issues for developing countries. The primary purpose of this paper is to provide the first systematic empirical evidence on this, and the first attempt to quantify the possible effects. Put simply, the question addressed is: Do BEPS, and tax competition, really matter for developing countries? There are, as will be seen, many imperfections in the precision with which these questions can be addressed. But the answer suggested here, to anticipate, is that they do indeed matter—and quite possibly even more than they do for advanced countries.

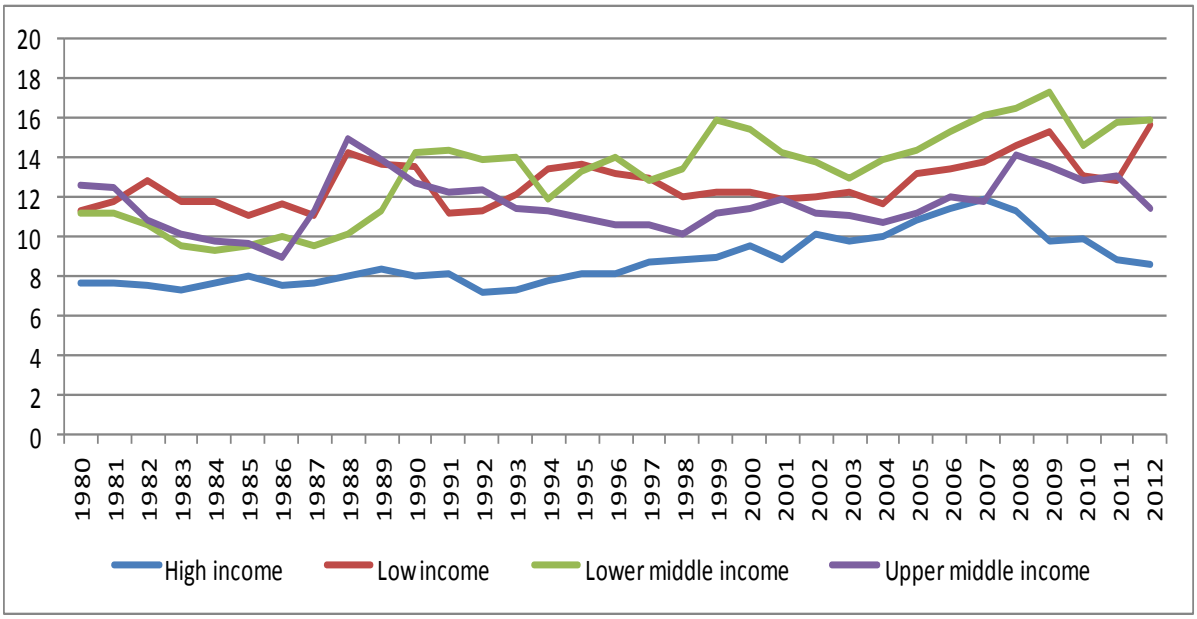
The analysis focuses on two distinct types of cross-border fiscal externality, or spillover, in international corporate taxation: 'base' and 'strategic' spillovers. By *base spillover* is meant the impact of one country's tax policy on the tax bases of other countries. This can arise through either an impact on real activities (through investment and the like) and/or through the shifting of paper profits. One of the contributions below is to develop and apply an approach enabling some disentangling of the two. By *strategic rate spillovers* is meant the

[2] Though important steps have been taken to involve developing countries in the BEPS process.

[3] Civil society has also drawn attention to particular instances, as for example in Action Aid (2010) (on which see also Schatan (2012)). OECD (2014) takes stock of specific BEPS action items most relevant for developing countries.

impact on a country's policy choices of tax changes abroad: tax competition, in its broadest sense.

**Figure 1. Revenue from the Corporate Income Tax, in Percent of Total Revenue**




Source: IMF Staff estimates; data from IMF's Fiscal Affairs Department database.
Note: Total tax revenue including grants and excluding social contributions; resource-rich countries excluded.

For advanced economies, there is a wealth of evidence on the magnitude of these base spillovers. One strand of research looks at such spillovers through the allocation of real investments; a meta study by De Mooij and Ederveen (2008) suggests that a 10 percentage point reduction in a country's average effective tax rate increases its stock of FDI, on average and in the long run, by over 30 percent. Another strand looks at base spillovers through profit shifting, without an underlying shift in real capital; Heckemeyer and Overesch (2013) report a consensus semi-elasticity of −0.8, implying that a 10 percentage point higher tax rate will reduce reported profit in an affiliate by 8 percent. And a rapidly growing number of studies, reviewed by Dharmapala (2014), explore more closely the various methods for profit shifting that multinationals used. What is absent from the existing literature, however, is similarly systematic evidence on base spillovers in developing countries.

In terms of strategic rate spillovers too, the evidence relates almost entirely to advanced economies: Devereux et al. (2008), for instance, find that among OECD countries a 10 percentage point decrease in the statutory CIT rates in other countries generates, on average, a cut of 7 percentage points in response.[4] The exception is Klemm and Van Parys (2012), who estimate fiscal reactions among Sub-Saharan African and Caribbean countries.

[4] See also the review in Leibrecht and Hochgatterer (2012).

They report smaller but significant strategic interactions in statutory corporate tax rates, in the order of 2.5 to 3 points in response to a 10 point tax cut abroad.
This paper aims to assess the size and significance of base and strategic rate spillovers, within an approach that provides some handle on the distinction between real and profit-shifting channels of effect—and in doing this to concentrate especially on the perspective of developing countries.[5] The focus is primarily on base spillovers, since these relate directly to current policy focus on BEPS; and indeed the approach adopted here enables an estimate, albeit very speculative indeed, of the revenue impact of international corporate tax avoidance—something the literature has struggled to do in a coherent way. To this end, we exploit aggregate data on corporate tax bases for a panel of 120 countries (and tax rates for 173 countries), over the period 1980–2013.

The next section sets out a framework for distinguishing the two distinct channels by which base spillovers can operate, discusses estimation strategy and describes the data. Section III reports results, including the implied revenue impact of BEPS activities involving tax 'havens'. Section IV concludes.

## II. METHODOLOGY AND DATA

### A. Theory

This section sets out a simple framework to guide the empirics, pointing to a strategy for distinguishing between the two types of corporate tax base spillover noted above: through the allocation of real investment, and through profit shifting. It does so by adding the possibility of profit shifting to the standard model for analyzing international tax effects of real investment (Zodrow and Mieskowski (1986) and Wilson (1986)).

Consider then a world of *n* countries, with country *i* populated by a fixed number $h_i$ of identical individuals who each supply one unit of labor (measured in efficiency units). The world population is normalized to unity ($\sum_{j=1}^{n} h_j = 1$), so that $h_i$ measures the relative 'size' of country *i*.

Production, and profit shifting, are undertaken by a single representative multinational. This has a single affiliate in each country, the revenue generated by its real activities in *i* being characterized by the function$f_i(k_i)$, where $k_i$ is the capital-labor ratio (and $h_i k_i$ therefore the total amount of capital in *i*), and $f_i$ is output per worker, with $f_i' > 0$ and $f_i'' < 0$, a prime

[5] Other studies, such as Clausing (2007), Brill and Hassett (2007) and Devereux (2007) have explored how corporate tax revenues (relative to GDP), rather than the base, vary with countries' own statutory CIT rates. Abbas and Klemm (2013) perform a similar analysis for 50 developing countries. The empirical results reported here of course have implications for that question, too, but for brevity, these are not pursued below.

indicating differentiation. The total capital available to the firm, to allocate across the *n* countries, is fixed at $\bar{k} = \sum_{j=1}^{n} h_j k_j$. The multinational may also shift tax base between its affiliates operating in the various countries: the base shifted into *i* from *j* is denoted by $s_{ij} = -s_{ji}$, with $s_{ii} = 0$. There is some cost to doing so, however; this, assumed to be independent of the location of real capital, is denoted by $c_{ij}(s_{ij})$, with $c'_{ij}$ strictly positive (negative) as $s_{ij}$ is strictly positive (negative) and $c''_{ij} > 0$.

The government in each country employs only a source-based tax on capital,[6] at rate $t_i$, the base of which is the sum of real capital located in *i* and base shifted into *i*:

$$b_i = h_i k_i + \sum_{j=1}^{n} s_{ij}. \tag{1}$$

Denoting by $\rho$ the world (tax-exclusive) interest rate, which the multinational takes as given—or, alternatively, interpreting $\rho$ as the shadow value of the multinational's aggregate capital—and assuming for simplicity that the costs of base-shifting are not tax-deductible, the multinationals' after-tax profit is:

$$\Pi = \sum_{i=1}^{n} \left\{ h_i f_i(k_i) - \rho h_i k_i - t_i \left( h_i k_i + \sum_{j \neq i}^{n} s_{ij} \right) - \sum_{j \neq i}^{n} c_{ij}(s_{ij}) \right\} . \tag{2}$$

The multinational thus has two decisions to take: the allocation of its real capital across countries; and the artificial shifting of tax base between them. We consider each of these, and the quite different ways in which they are affected by taxation, in turn.

Taking first the allocation of real capital, maximizing (2) implies the necessary conditions:

$$f_i'(k_i) = \rho + t_i \,, \qquad \mathrm{i} = 1, \ldots, n. \tag{3}$$

These simply say that the multinational will allocate its capital to equalize the after-tax return across its affiliates: otherwise it could earn more by reallocating assets to wherever the after-tax return is greatest. Equation (3) implicitly defines the capital thus allocated to *i* as a function $k_i(t_i, \rho)$ of the tax rate in *i* and the world interest rate (decreasing in both). The condition that all capital be allocated, $\sum_{j=1}^{n} h_j k_j(t_j, \rho) = \bar{k}$, then defines $\rho$ as a function of all tax rates, and hence the capital allocation to each country as a function $k_i(t_1, .., t_n)$ of all tax

[6] A richer treatment would differentiate between one tax directed to the use of capital and another on profits attributed to each jurisdiction. These would then act differently on real investment decisions and base shifting (along the lines of Keen and Konrad (2013)). Though it is somewhat artificial to think of base shifting in terms of apparent amounts of real capital employed rather than attributed profits, the single instrument specification here suffices, given limitations on the tax rate data available, for the central purpose of guiding the empirics. These, as will be seen, consider (subject to data availability) the impact of both statutory tax rates (likely most relevant for profit shifting) and effective tax rates (likely most relevant for investment decisions).

rates. The structure of tax effects this implies are complex. One key driver emerges clearly, however, on supposing each production function to be quadratic (perhaps with different parameters). For this case, Keen and Konrad (2013) show that:

$$\frac{\partial k_i}{\partial t_i} = -(1 - h_i) < 0 \tag{4}$$

$$\frac{\partial k_i}{\partial t_j} = h_j \ > 0 \quad . \tag{5}$$

Size thus plays a critical role in determining the magnitude of both own and cross-border tax effects. The increase in real investment in *i* consequent upon a tax change in some other country *j,* for instance, is greater the larger is country *j*. This has evident intuitive appeal: one would not, for instance, expect real investment in a major advanced economy to be much affected by the tax rate set by a small island economy.

The same is not true, however when it comes to base shifting. Turning to this second dimension of the multinational's decisions, the first-order condition with respect to $s_{ij}$ (recalling that this also appears as $-s_{ji}$) is

$$c'_{ij}(s_{ij}) + c'_{ji}(s_{ij}) = t_j - t_i \quad \forall i, \forall j \neq i \ \text{ such that } t_j > t_i \ . \tag{6}$$

The multinational thus shifts base from a high tax jurisdiction *j* into *i* until the tax saved on the marginal dollar shifted just equals the associated transaction costs. Assuming, for simplicity, that these costs are quadratic, with $c_{ij}(s_{ij}) = \frac{1}{2}\Delta_{ij}s_{ij}^2$ , the tax responsiveness of base shifting is given by:

$$\frac{\partial s_{ij}}{\partial t_j} = -\frac{\partial s_{ij}}{\partial t_i} = \frac{1}{\delta(i,j)} > 0 \ , \tag{7}$$

where $\delta(i,j) \equiv \Delta_{ij} + \Delta_{ji}$. The effect of a tax increase in some country *j* on the base shifted into *i*, unlike that on real investment, is thus independent of either country's size, and of the real capital located in each,[7] but depends only on the ease with which base can be artificially shifted between them. This too is intuitive: even a large advanced economy may be exposed to profit shifting as a result of low tax rates offered by a small island economy.

Combining these two types of effect—on real investment and base shifting—the effect on country *i*'s of an arbitrary small change $(dt_1, .., dt_n)$ in all tax rates, $db_i = h_i dk_i + d(\sum s_{ij})$, can be written in per capita terms, using (4), (5) and (7) as:

[7] The separation of the decisions on $k_i$ and the $s_{ij}$ that emerges here is, of course, extreme, They would become linked if, as is very plausible, shifting tax base into a county is easier if there is some real activity there.

$$\frac{db_i}{h_i} = \beta_i \left( dt_i - \sum\nolimits_{j \neq i} \omega_{ij} dt_j \right) \tag{8}$$

where

$$\beta_i \equiv -\left\{ (1 - h_i) + \sum\nolimits_{j \neq i}^{n} \left( \frac{1}{h_i \delta(i,j)} \right) \right\} < 0 \tag{9}$$

and

$$\omega_{ij} \equiv \frac{h_j + \left( \frac{1}{h_i \delta(i,j)} \right)}{1 - h_i + \sum_{p \neq i} \left( \frac{1}{h_i \delta(i,p)} \right)} . \tag{10}$$

The impact of any tax change on the tax base of country *i* thus depends entirely on how it affects the difference between *i*'s own rate and a weighted average of the tax rates in all other countries, with the structure of the weights $\omega_{ij}$ capturing the two distinct routes by which tax rate changes abroad can impact the tax base in *i*. This suggests an empirical strategy for distinguishing between them. If base effects operate only through real investment (as would be the case if the marginal costs of profit shifting $\delta$ were infinitely large), the weights become

$$\omega_{ij} = \frac{h_j}{1 - h_i} \tag{11}$$

so that the impact of the tax rate in country *j* on the domestic tax base in *i* depends only on the size of *j* relative to all countries other than *i*. If, in contrast, these impacts operate only through profit shifting (as would be case for a single country dwarfing all others) the appropriate weights become

$$\omega_{ij} = \frac{1/\delta(i,j)}{\sum_{p \neq i} \delta(i,p)} \tag{12}$$

and it is tax rates in foreign countries weighted simply by the relative ease with which profits can be shifted in or out of them that matters.

One other implication of (9) is that the strength of the tax effects, captured in the $\beta_i$, will generally vary across countries; we will also explore the possibility of systematic differences between, in particular, developing and other economies.

### B. Specification and Estimation

Base spillovers are explored by estimating equations of the form:

$$b_{it} = \lambda b_{it-1} + \varphi \tau_{it} + \gamma \boldsymbol{W_{-i} \tau_{-it}} + \boldsymbol{\zeta' X_{it}} + \alpha_i + \mu_t + \varepsilon_{it} \tag{13}$$

where $b_{it}$ denotes the corporate income tax (CIT) base in country $i = 1, .., n$ at time $t = 1, .., L$ (with the lag allowing for sluggish response), $\tau_{it}$ is the domestic CIT rate, $W_{-i}\tau_{-it}$

denotes some weighted average $\sum_{j\neq i}^{n}\omega_{ij}\tau_{jt}$ of the statutory CIT rates in countries $j \neq i$ (with $\sum_{j\neq 1}^{n}\omega_{ij} = 1$), $\boldsymbol{X}_{it}$ is a vector of controls and $\alpha_i$ and $\mu_t$ are country- and time-specific effects. The analysis above implies that, for an appropriate choice of weights, $\varphi = -\gamma$; we allow these coefficients to differ in the base regressions (as might be plausible given, for instance, the presence of some immobile capital, not allowed for in the analytics), and treat their equality as a testable restriction.

With $\varphi$ in (13) being the short run marginal impact of a country's own CIT rate on its own CIT base, the long run impact is given by $\theta(\varphi) \equiv \varphi/(1-\lambda)$; both are expected to be negative. The main focus here, however, is on base spillover effects from the tax rates set by others. This is captured by the coefficient $\gamma$ for the short run, and by

$$\theta(\gamma) \equiv \frac{\gamma}{1-\lambda} \tag{14}$$

for the long run, with both expected to be positive.

As analyzed above, the two channels through which such base spillover effects may operate[8]—effects on real investment decisions, and on base shifting—imply different structures for the appropriate weighting matrix in (13). This provides a way to assess the importance of each channel. We consider three possibilities. First, to capture the idea that spillover effects from foreign tax rates depend on relative country size, we construct the weighting matrix $\boldsymbol{W}_{-i}$ for country *i* in the spirit of equation (11), by weighting the tax rate in each foreign country *j* by *j*'s GDP as a share of the total GDP of all countries other than *i*; we refer to these as 'GDP-weighted' rates.[9] Second, to capture the possibility of spillovers through profit shifting, we also consider—in the absence of direct data on the ease of shifting profits in and out of each country (the $\delta(i,j)$above)—an unweighted average of rates only in those jurisdictions that are included in a commonly-used list of 'tax havens'; these are referred to as 'haven-weighted' rates.[10] The third possibility considered is that spillovers may

[8] One possibility not captured in the model above is that countries may in part react to changes in tax rates abroad by policy measures affecting their domestic tax base: adopting special incentive schemes, for instance, or more generous depreciation allowances. These effects will be captured in the empirics, though in the absence of detailed information on tax bases they cannot be measured directly.

[9] The use of GDP as an indicator of size is not entirely clean, since, as OECD (2015) notes, measured GDP may be affected by profit shifting (through, for instance, mispricing of exports and imports). This though seems likely to be of second order importance (certainly less marked than effects on GNP) and provides another reason for the instrumenting described below.

[10] The assumption in this case is thus it is equally easy to shift profits in/out of all 'havens', but impossible to shift profit through non-havens.

be greater from geographically closer countries, captured by weighting tax rates by the inverse-distance between capitals.[11]

A particular identification issue arises when using the haven-weights. Since this variable does not differ across non-haven countries, for them it is indistinguishable from a time effect; and for each haven country it is readily seen to be a linear combination of its own tax rate and the average rate across all havens, the latter equivalent to that same time effect. To address this, we take the same approach as Devereux and others (2008) and restrict the form of time effects by assuming a common linear time trend. Imposing the restriction $\varphi = -\gamma$, as (after testing) we shall, is another route to identification, with no need to restrict time effects.[12]

We also explore—more briefly—strategic rate spillovers, following Devereux and others (2008) in estimating

$$\tau_{it} = b\boldsymbol{W}_{-i}\boldsymbol{\tau}_{-it} + \boldsymbol{\zeta}'\boldsymbol{X_{it}} + a_i + c_t + \epsilon_{it}\,, \qquad (15)$$

but differing from previous work in considering the same three weighted average tax rate constructs as for base spillovers. Though not formally modeled here, the reason for doing so is simply that one would expect rate-setting responses to be most sensitive to those tax rate choices abroad that most directly affect a country's own tax base. The specification in (15) includes the same controls as in the base spillover estimation and again includes country effects and a common time trend; as in the previous literature, the lagged dependent variable is omitted.

The empirical strategy just set out has significant limitations, largely reflecting those of the available data. Cross-border real investment decisions, for instance, are likely to be driven not by the statutory rate of CIT alone, but by an average effective tax rate (AETR) that also reflects depreciation and other allowances (Devereux and Griffith, 1998). Data on AETRs are not available, however, for as many countries or as long a period as are statutory rates; and, as Dharmapala (2014) stresses, the dependence of calculated AETR on elements of the tax base creates a distinct endogeneity issue. Nonetheless, the use of AETRs, where available, rather than statutory rates can provide a useful additional perspective, and is pursued in Appendix 2.

[11] A further possibility is to take $\boldsymbol{W}_{-i}$to be the simple average rate over all countries other than *i*: this though raises still more sharply the identification challenge mentioned below, and for brevity the results are not reported here.

[12] Using country-specific trends instead of a common trend gives very similar results, not reported here.

Perhaps more troubling data limitations relate to the estimation of effects operating through tax havens. The difficulty is that the attractions of tax 'havens' do not solely, or even mainly, derive from low statutory CIT rates, but from special regimes and arrangements for which descriptive data are unavailable.[13] The identification of haven effects thus depends on a plausible but (on our data) untestable correlation between movements in their statutory rates and special regimes. The results, for this reason, can be no more than indicative.

Equations (13) and (15) are estimated by system generalized method of moments (GMM), using only internal instruments. While the panel is sufficiently long that Nickell bias may not be a significant concern, other endogeneity issues arise. In the base spillover regression, shocks that affect a country's domestic tax base may also affect its contemporaneous tax rate choice, for instance; and the estimation of the CIT base by simply dividing revenues by the main statutory rate (as described below) can give rise to measurement error when, as is quite often the case, more than one CIT rate is applied. In the strategic rate spillover equation, tax rates are evidently jointly determined across countries.

## C. Data

The sample is an unbalanced panel comprising 173 countries over 1980–2013. The countries in the sample, identifying those labeled, following Gravelle (2013), as 'havens', classified by income group and as between OECD members and non-members (at the end of the sample period), are listed in Appendix 1. The latter group comprises a wide range of countries, of course, but for brevity we sometimes refer to this as the group of developing countries, lower income countries indeed being heavily represented in the sample. Data on CIT revenues and statutory tax rates are from the IMF's Fiscal Affairs Department database. The country coverage of CIT rates is full, though unbalanced in the time dimension.

To eliminate artificial variation in the weighted average tax rates as a result of missing observations for certain country-year pairs, we linearly interpolated the tax rate series for years with missing tax rates. The balanced panel of tax rates this creates is used only for calculating the weighted average tax rates; own tax rates in all regressions are actual values, not interpolations.

[13] Over the full sample period, the average CIT rate in the 'havens' is around 17 percent, compared to 32 percent for the full sample (Table 1): see also Figure 2. Many havens are small, however, and a low rate is common among smaller countries more generally. Regressing the CIT rate on country size (which enters with a significant positive coefficient, as models of tax competition would predict) and a dummy for tax haven status (and the using other controls being used), it emerges that tax-havens actually have, on average, a significantly higher CIT rate than otherwise similar countries.

Resource-rich countries[14] are excluded from the exercise in the sense that their tax bases are not treated as dependent variables, since they will likely have distinct drivers and reflect a variety of distinct tax design choices; the tax rates set by these countries are, however, included in constructing the various average tax rates used as explanatory variables. As mentioned above, the CIT base in percent of GDP, $b_i$, is calculated by dividing CIT revenue in recent of GDP by the standard CIT rate; lack of revenue data means that this is possible for only 121 countries. The far more limited data on average effective tax rates (AETR) used in Appendix 2, for 43 countries[15] over the period 1996–2007, are from Abbas and Klemm (2013).

The controls $\boldsymbol{X}$ in (13) and (15), are ones that have commonly been used in modeling tax revenues and rates:[16] (the log of) GDP per capita, the share of agriculture in value-added, trade openness (the sum of non-resource exports plus imports, relative to GDP), and inflation.[17]

Table 1 provides descriptive statistics. The mean statutory CIT rate in the sample is 32 percent. The average of the GDP-weighted CIT rates is greater, reflecting somewhat higher CIT rates in larger countries (as the tax competition literature predicts). And the haven-weighted average CIT rate is substantially lower, at 17 percent. The mean AETR is approximately 22 percent, lower than the mean statutory CIT rate (to be expected, since the AETR reflects various deductions in calculating the tax base). Figure 2 shows the movement of mean statutory CIT rates over time for OECD and non-OECD countries, and (interpolated) for the havens. There has been a very pronounced decline, by 15 to 20 percentage points over the last three decades, in both groups. Over the full sample, mean CIT revenue is around 2.6 percent of GDP, while the CIT base averages around 8.6 percent of GDP, with a fairly large standard deviation of 5.4.

[14] These are: Bahrain, Chad, Republic of Congo, The Islamic Republic of Iran, Kazakhstan, Kuwait, Libya, Mexico, Nigeria, Norway, Oman, Russian Federation, Saudi Arabia, Syrian Arab Republic, Trinidad and Tobago, United Arab Emirates, Venezuela, and Yemen.

[15] These are: Argentina, Botswana, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Czech Republic, Ecuador, Egypt, Estonia, Ghana, Hong Kong SAR, Hungary, India, Indonesia, Israel, Kenya, Korea, Latvia, Lithuania, Malaysia, Mauritius, Morocco, Namibia, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Senegal, Singapore, South Africa, Sri Lanka, Tanzania, Thailand, Turkey, Uganda, Ukraine, Uruguay, and Zambia.

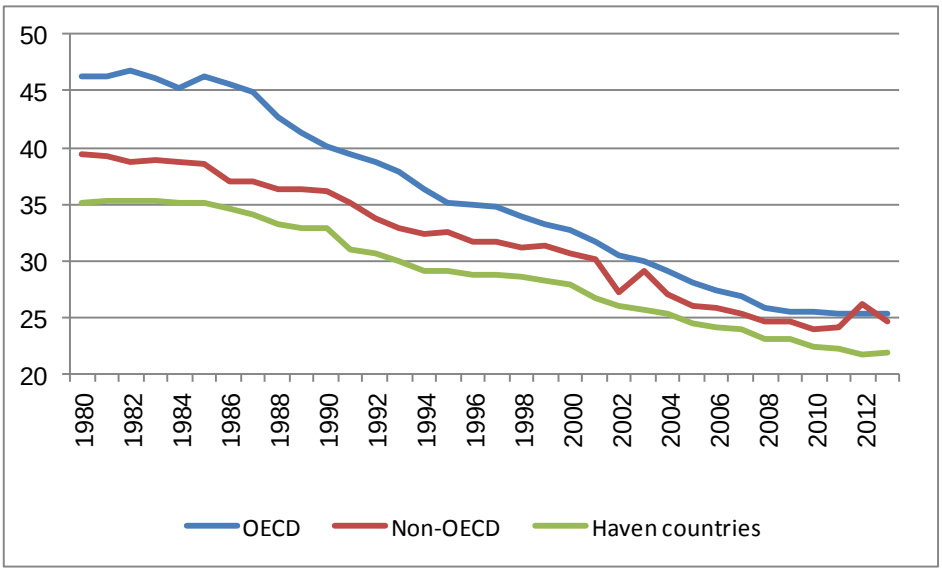
[16] See, for example, Benedek and others (2014) and Crivelli and Gupta (2014).

[17] The share of agriculture in aggregate value added is taken from the World Development Indicators (WDI) database; trade openness is calculated from the IMF's International Financial Statistics (IFS) database; per capita GDP is in constant (2000) U.S. dollars, taken from the WDI; inflation is the annual change in the consumer price index, taken from the IFS.

**Table 1. Descriptive Statistics**

| | Obs. | Mean | Max. | Min. | Std. Dev. |
|---|---|---|---|---|---|
| Statutory CIT Rate, in percent | 3037 | 32.15 | 61.80 | 0.00 | 10.85 |
| GDP-weighted average tax rate, in percent | 3037 | 39.18 | 48.04 | 26.98 | 5.28 |
| Haven-weighted average CIT rate, in percent | 3037 | 17.09 | 24.46 | 11.08 | 3.55 |
| Inverse-distance-weighted average CIT rate, in percent | 4771 | 32.08 | 42.18 | 18.60 | 4.60 |
| CIT revenue, percent of GDP | 2161 | 2.64 | 13.37 | 0.00 | 1.53 |
| OECD countries | 913 | 2.76 | 8.02 | 0.26 | 1.28 |
| Non-OECD countries | 2354 | 2.42 | 18.40 | 0.01 | 1.98 |
| CIT base, percent of GDP | 2161 | 8.59 | 29.99 | 0.00 | 5.45 |
| OECD countries | 893 | 8.75 | 29.99 | 1.06 | 4.61 |
| Non-OECD countries | 1268 | 8.47 | 29.73 | 0.00 | 5.97 |
| AETR, in percent | 508 | 22.23 | 40.27 | -11.61 | 9.24 |
| GDP-weighted AETR, in percent | 508 | 25.69 | 32.29 | 22.69 | 1.10 |
| Simple average AETR, in percent | 508 | 21.68 | 25.20 | 1.54 | 3.08 |
| Agricultural value-added, percent of GDP | 1817 | 11.71 | 64.05 | 0.04 | 10.80 |
| GDP per capita, 2000 USD | 1970 | 13349 | 87716 | 126 | 15353 |
| Trade openness, percent of GDP | 1974 | 79.04 | 436.95 | 6.32 | 45.66 |
| Inflation, in percent | 1925 | 36.46 | 11749.64 | -4.47 | 368.39 |

**Figure 2. Corporate Income Tax Rates, 1980–2013**



## III. RESULTS

This section presents and discusses estimation results, dealing in turn with base spillovers as in equation (13) and strategic rate spillovers as in equation (15). Results using AETRs rather than statutory CIT rates are reported in Appendix 2.

### A. Base Spillovers

Table 2 reports the results of estimating (13) using the three different weighting matrices described above: column (1) uses GDP-weighted rates; column (2) uses the haven-weighted average; and column (3) uses rates weighted by the inverse distance between capital cities. The diagnostics are satisfactory in the Arellano and Bond (1991) tests for first- and second-order serial correlation (M1 and M2) and in the Hansen statistics.[18] The control variables generally play no significant role in explaining corporate tax bases; for brevity, estimated coefficients on the controls are omitted in subsequent tables.

The impact of country *i*'s CIT rate on its own base is in all columns negative, as expected, and strongly significant. The short-run marginal coefficient of −0.08 in column (1), for instance, means that a one percentage point increase in a country's CIT rate will reduce its CIT base by 0.08 percent of GDP. Evaluated at a mean CIT base of 8.59 percent of GDP, this implies a (short run) semi-elasticity[19] of the corporate tax base with respect to its own rate of −0.9:[20] that is, a one percentage point higher CIT rate reduces its own base by just under one percent. This is very close to the consensus value from the prior literature for advanced economies reviewed in Dharmapala (2014), as cited above. Sluggish response means that the point estimates of the long run effects are much larger: $\theta(\varphi)$ in column (1) suggests that a one point higher own CIT rate ultimately reduces the CIT base by over one percent of GDP; in this case, however, a large standard error means that the null of no long run effect cannot be rejected. The own-tax effects for the haven-weighted case are of similar magnitude but with the long run effect significant at 5 percent. For the inverse distance weighted average case in column (3), own tax effects are similar in the short run to those in the other columns, but the long-run effect is again insignificant.

[18] The same is true for most results reported here.

[19] Complicating the comparison of our results with the previous literature is that the latter makes no clear distinction between short- and long-run effects.

[20] Calculated as $(0.08/8.79) \times 100$.

**Table 2. Base Spillovers with Alternative Weighting Matrices** 1/

| | (1) | (2) | (3) |
|---|---|---|---|
| CIT Base, lagged | 0.9294*** | 0.8785*** | 0.9191*** |
| | (0.0577) | (0.0670) | (0.0601) |
| CIT rate *i* | -0.0818*** | -0.0991*** | -0.0804** |
| | (0.0396) | (0.0413) | (0.0396) |
| CIT rate *j*, weighted GDP | 0.1763* | | |
| | (0.0982) | | |
| CIT rate *j*, weighted tax havens | | 0.3544** | |
| | | (0.1698) | |
| CIT rate *j*, weighted inverse-distance | | | 0.3317* |
| | | | (0.1998) |
| Agriculture share | 0.0918 | 0.0874 | 0.0768 |
| | (0.0718) | (0.0971) | (0.0891) |
| GDP per capita (log) | 0.8295 | -0.1024 | 0.9210* |
| | (1.1506) | (1.4015) | (0.5874) |
| Trade Openness | 0.0115 | 0.0521 | 0.0310* |
| | (0.0151) | (0.0237) | (0.0170) |
| Inflation (log) | 0.2079 | 0.1155 | 0.2974 |
| | (0.3179) | (0.3645) | (0.3275) |
| Time Trend | 0.0638 | 0.1591** | 0.1462* |
| | (0.0616) | (0.0792) | (0.0910) |
| $\theta(\varphi)$ | -1.1608 | -0.8165** | -0.9954 |
| | (1.0649) | (0.4739) | (0.7786) |
| $\theta(\gamma)$ | 2.5015 | 2.9185* | 4.1062 |
| | (2.7913) | (1.8219) | (3.3698) |
| $\gamma = -\varphi$ (p value) | 0.329 | 0.120 | 0.204 |
| Restricted Coefficient | 0.0885** | 0.0986*** | 0.0832** |
| | (0.0390) | (0.0413) | (0.0395) |
| M1 (p value) | 0.001 | 0.001 | 0.000 |
| M2 (p value) | 0.780 | 0.859 | 0.789 |
| Over-identification | | | |
| Hansen (p value) | 0.452 | 0.523 | 0.385 |
| Observations | 1540 | 1694 | 1687 |
| Number of instruments | 82 | 58 | 73 |
| Number of countries | 100 | 105 | 103 |

Note: Dependent variable is the CIT base. Full set of control variables in all regressions. Robust standard errors, in parentheses; ***, **,* indicate significance at 1, 5, 10 percent.

1/ One step, robust, system GMM with instruments based on first lag of differences in the CIT tax base (collapsed to avoid proliferation in the number of instruments) in levels equation, and second lags of their levels in the differenced equation.

The central concern here, of course, is with the base spillover effects, $\gamma$ and $\theta(\gamma)$. Column (1) shows a large positive coefficient for the GDP-weighted average foreign tax rate, interpreted here as relating to spillovers through real capital flows: a one percentage point reduction in the GDP-weighted average CIT rate abroad reduces the typical country's CIT base in the short run by 0.18 percent of GDP: a short-run semi-elasticity of over two. The long run effect, however, is insignificant.

Estimated base spillover effects in the haven-weighted case of column (2) are larger and more significant, though only at 10 percent in the long run. In column (3) the estimated spillover effects when weighting tax rates by inverse distance are similar, but barely significant.

Also reported in the table, and in those to follow, are the p-values from testing the restriction that $\varphi = -\gamma$: the null that, as in the model of Section II, the base spillover and the own-tax effects are identical. This is not rejected for any of the weight structures. Imposing the restriction, which should then lead to an improvement in efficiency, leads to point estimates of around 0.9,significant in all cases and strongly so for the haven weights.

Two points stand out from these initial results. The first is that for each of the alternative weights, signs of significant own and cross price effects emerge, broadly consistent with theory: both real and profit-shifting effects thus seem to be at work. Second, of the three weights, it is the haven weights that give rise to larger and more significant effects. Noticeable too is that while delayed response substantially increases the magnitude of estimated long-run tax effects, little can be concluded from this since these effects are imprecisely determined.

These results presume that tax effects are the same for all countries, which as noted earlier the theory suggests may not be the case. Of particular interest here is the possibility that these effects may vary systemically between OECD members and others. How important are they, in particular, for non-members?

To explore this, Table 3 reports the results of estimating (13) for distinct subgroups of countries using haven-weighted tax rates; the results are similar using other weights[21] Results are shown for all countries (column 1, repeating column 3 of Table 2), OECD countries (column 2), and non-OECD countries (column 3).

[21] The weighted average tax rate in each of those cases is of course calculated over the full sample of countries.

**Table 3. Base Spillovers by Income Level, 'Haven'-Weighted Tax Rates** 1/

| | All | OECD | Non-OECD |
|---|---|---|---|
| | (1) | (2) | (3) |
| CIT Base, lagged | 0.8785*** | 0.7681*** | 0.8535*** |
| | (0.0670) | (0.0487) | (0.0665) |
| CIT rate *i* | -0.0991*** | -0.0596* | -0.1376** |
| | (0.0413) | (0.0371) | (0.0657) |
| CIT rate *j*, haven weighted | 0.3544** | 0.3423** | 0.4421* |
| | (0.1698) | (0.1767) | (0.2718) |
| $\theta(\varphi)$ | -0.8165** | -0.2571 | -0.9398* |
| | (0.4739) | (0.1695) | (0.5169) |
| $\theta(\gamma)$ | 2.9185* | 1.4761** | 3.0192 |
| | (1.8219) | (0.7760) | (2.0487) |
| $\gamma = -\varphi$ (p value) | 0.120 | 0.117 | 0.265 |
| Restricted coefficient | 0.0986*** | 0.0527 | 0.1482** |
| | (0.0413) | (0.0416) | (0.0650) |
| M1 (p value) | 0.001 | 0.001 | 0.003 |
| M2 (p value) | 0.859 | 0.773 | 0.840 |
| Over-identification | | | |
| Hansen (p value) | 0.523 | 0.844 | 0.642 |
| Observations | 1694 | 624 | 956 |
| Number of instruments | 58 | 40 | 58 |
| Number of countries | 105 | 28 | 74 |

Note: Dependent variable is the CIT base. Full set of control variables and common time trend in all regressions. Robust standard errors, in parenthesis; ***(**,*) indicate significance at 1(5, 10) percent.

1/ One step, robust, with instruments based on first lag of differences in the CIT tax base and CIT tax rates (collapsed to avoid proliferation in the number of instruments) in levels equation, and second lags of their levels in the differenced equation.

The own-tax effect, while seen to be strongly significant over the full sample, is now less significant for the two subsamples, most notably for OECD members, with the point estimate larger and more significant for non-OECD countries. The short run base spillover effect is significant for both OECD and non-OECD members, being larger but somewhat less significant for the latter; the long run base spillover is significant only for OECD members. Imposing the equality of coefficients on own and spillover effects (which is again not rejected) suggests, however, the restricted coefficient becomes insignificant for OECD members while for non-members it is significant and about three times as large, with an implied semi-elasticity around 1.8.

Table 4 explores more closely the nature of the base spillover affecting non-OECD countries, presenting results for each of the three weighting schemes used in Table 2. (Column (2) thus repeats column (3) of Table 3). The broad pattern of results is similar to that for the full sample in Table 2, but the significance of both own-rate and spillover effects is lower. Indeed spillover effects are insignificant when using either GDP- or inverse distance-weighted averages; it is only in the haven-weighted case that spillover effects, as well as own effects, appear to be at work.

**Table 4. Base Spillovers in Non-OECD Countries** 1/

| | (1) | (2) | (3) |
|---|---|---|---|
| CIT Base, lagged | 0.8169*** | 0.8535*** | 0.8572*** |
| | (0.0817) | (0.0665) | (0.0620) |
| CIT rate *i* | -0.1206* | -0.1376** | -0.1126* |
| | (0.0727) | (0.0657) | (0.0624) |
| CIT rate *j*, weighted GDP | 0.1324 | | |
| | (0.1410) | | |
| CIT rate *j*, weighted tax havens | | 0.4421* | |
| | | (0.2718) | |
| CIT rate *j*, weighted inverse distance | | | 0.0525 |
| | | | (0.3296) |
| $\theta(\varphi)$ | -0.6588 | -0.9398* | -0.7892* |
| | (0.4517) | (0.5169) | (0.4897) |
| $\theta(\gamma)$ | 0.7236 | 3.0192 | 0.3683 |
| | (0.8184) | (2.0487) | (2.3098) |
| $\gamma = -\varphi$ (p value) | 0.935 | 0.265 | 0.852 |
| Restricted coefficient | 0.1224* | 0.1482** | 0.1126* |
| | (0.0691) | (0.0650) | (0.0624) |
| M1 (p value) | 0.004 | 0.003 | 0.000 |
| M2 (p value) | 0.653 | 0.840 | 0.793 |
| Over-identification | | | |
| Hansen (p value) | 0.433 | 0.642 | 0.731 |
| Observations | 916 | 956 | 949 |
| Number of instruments | 58 | 58 | 72 |
| Number of countries | 72 | 74 | 73 |

Note: Dependent variable is the CIT base. Full set of control variables and common time trend in all regressions. Robust standard errors, in parenthesis; ***(**,*) indicate significance at 1 (5, 10) percent.

1/ One step, robust, with instruments based on first lag of differences in the CIT tax base and CIT tax rates (collapsed to avoid proliferation in the number of instruments) in levels equation, and second lags of their levels in the differenced equation.

The impression thus emerges that spillover effects matter at least as much for non-OECD members as for members, and that those operating through profit-shifting are at least as strong as those through real effects. To explore the relative importance of these channels of effect more closely, Table 5 reports on the results of including in the regression—consistent with the theory in Section II—both the GDP-weighted and haven-weighted average tax rates; in column (1) for the full sample, in column (2) for the OECD, and in column (3) for non-OECD members.

There emerges an interesting difference between OECD and non-OECD subsamples. For the former, it is the GDP-weighted spillover effect—and hence, presumptively, real effects—that dominates, with a semi-elasticity of around 1.7 (while the own effect, as in Table 3, is surprisingly insignificant). For the non-OECD subsample, in contrast, it is the haven effect—

presumptively, profit shifting—that dominates, and, though not very precisely determined, implies a very large semi-elasticity of 5.4 (with the own effect for this group significant).[22]

**Table 5. Including both GDP- and Haven-weighted Averages** 1/

| | Full sample | OECD | Non-OECD |
|---|---|---|---|
| CIT Base, lagged | 0.8951*** | 0.7712*** | 0.8536*** |
| | (0.0663) | (0.0571) | (0.0667) |
| CIT rate *i* | -0.0911** | -0.0582 | -0.1375** |
| | (0.0426) | (0.0439) | (0.0656) |
| CIT rate *j*, weighted GDP | -0.0260 | 0.1533* | 0.0056 |
| | (0.0802) | (0.0835) | (0.1311) |
| CIT rate *j*, weighted tax havens | 0.3640* | 0.0575 | 0.4417* |
| | (0.2103) | (0.1228) | (0.2713) |
| $\theta(\varphi)$ | -0.8701* | -0.2545 | -0.9398* |
| | (0.6205) | (0.1865) | (0.5166) |
| $\theta(\gamma)$, havens | 3.4736 | 0.2515 | 3.0178 |
| | (2.5919) | (0.5233) | (2.0444) |
| M1 (p value) | 0.001 | 0.001 | 0.003 |
| M2 (p value) | 0.757 | 0.522 | 0.841 |
| Over-identification | | | |
| Hansen (p value) | 0.500 | 0.805 | 0.637 |
| Observations | 1540 | 624 | 956 |
| Number of instruments | 55 | 37 | 58 |
| Number of countries | 100 | 28 | 74 |

Note: Dependent variable is the CIT base. Full set of control variables and common time trend in all regressions. Robust standard errors, in parenthesis; ***(**,*) indicate significance at 1(5, 10) percent.

1/ One step, robust, with instruments based on first lag of differences in the CIT tax base and CIT tax rates (collapsed to avoid proliferation in the number of instruments) in levels equation, and second lags of their levels in the differenced equation.

## B. The Revenue Cost of BEPS

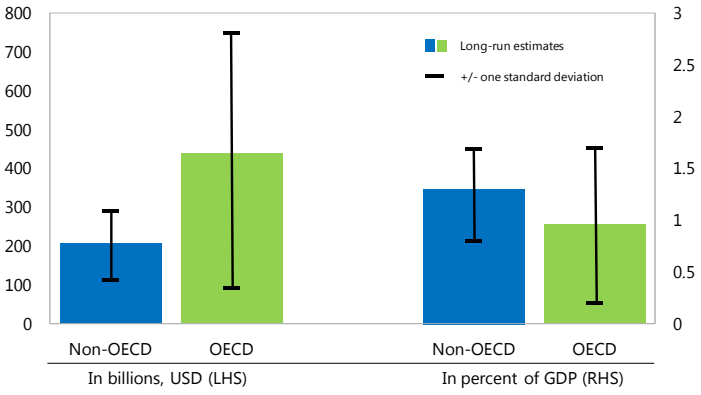
For all the importance attached to the issue in public debate and the recent high profile political initiatives, persuasive quantification of the revenue at stake through cross-border tax avoidance has proved elusive: Fuest and Riedel (2009), for instance, provide a forceful critique of many of the estimates that have been made. In one of the most careful exercises, Gravelle (2013) puts the loss to the U.S. from selected avoidance techniques at what was then around 25 percent of corporate tax revenues, which is in the order of 0.6 percent of GDP.

[22] This may understate the impact through real investment decisions: results in Appendix 2 find a significant effect (albeit for a much smaller sample) from the GDP-weighted average of AETRs abroad, which as noted above are in principle likely to be a better indicator of tax effects on location decisions.

The analysis here provides one simple, albeit highly speculative, way to size the possible effects of BEPS. Those avoidance effects operating through tax havens, at least, can in principle be assessed by simply 'turning off' the effects on tax bases operating through that channel, calculating the implied changes in tax bases, and multiplying by the applicable CIT rate. Conceptually, this corresponds to setting the profit shifting cost parameters $\delta(i,j)$ of the analysis above to infinity and evaluating the revenue impact at unchanged tax rates.

By way of illustration, Figure 3 shows the results of such an exercise, distinguishing between OECD and non-OECD members, using the restricted coefficients in Table 3 along with the statutory tax rates and estimated CIT bases of 2013.[23] It shows the point estimates of the long-run effects, along with the one standard deviation range, in both nominal terms (left hand scale) and in percent of GDP (right hand); short-run effects are spelt out in the box underneath the figure.

**Figure 3. Illustrative Revenue Loss Calculations**




Short-run estimates

| | USD, billions | Percent of GDP |
|---|---|---|
| Non-OECD | 28 | 0.2 |
| OECD | 95 | 0.2 |

Note: Averages are calculated as sum of revenue effects across countries relative to their aggregate GDP (equivalent to a GDP-weighted average of national effects relative to national GDP.

In dollar terms, the revenue apparently at stake is, as one would expect, much larger for OECD members. Relative to GDP, the implied long run revenue losses for these countries are in the order of 1 percent of GDP—close to the estimate of Gravelle (2013). Notable, however, while far smaller in absolute terms, relative to GDP the apparent revenue losses are if anything somewhat larger in developing countries, at around 1.3 percent of GDP. This is a significant amount, especially relative to their lower levels of overall revenue: the median

[23] The coefficients on the lagged dependent variable used in the calculations, not reported tin Table 3, are 0.78 for the OECD members and 0.86 for the non-OECD.

ratio of tax revenue to GDP in low income countries is around 15 percent, compared to about 35 percent in the OECD). There are of course very many caveats to these estimates, with particular reservations related to the haven-weighting stressed above. While they are thus no more than illustrative, the pattern of effects that emerges again suggests that the issues at stake may well be more pressing for developing countries than for advanced.

### C. Strategic Rate Spillovers

Results on strategic rate spillovers—countries' rate-setting responses to the tax rates set elsewhere—are reported in Table 6 for the full sample of countries and the subsamples of OECD and non-OECD members. For brevity, we focus on just two of the weighting schemes: by GDP (first row) and haven weighted (second row).

In all cases, the positivity and (albeit modest) significance of the spillover coefficient indicates strategic complementarity in tax-setting: that is, countries respond to tax rate reductions elsewhere by cutting their own tax rate. That response is strikingly high for OECD countries, and one cannot reject the null that a one point cut in the rate abroad (whether GDP- or haven-weighted) elicits a one point cut in response. The responsiveness of non-OECD members is less, with a one point cut abroad generating a cut of around two-thirds of a point. It stands out too that response is much more significant to GDP-weighted than to haven-weighted rates. This is as one might expect for OECD members given the results in Table 5, but less so for non-OECD given the greater importance for them of spillovers from havens suggested by the results there. It may be that changes in the larger economies are more salient for their policy making even though it is effects through other jurisdictions that ultimately affect them more.

**Table 6. Strategic Rate Spillovers by Income Level** 1/

| | Full sample | Full sample | OECD | OECD | Non-OECD | Non-OECD |
|---|---|---|---|---|---|---|
| CIT rate *j*, weighted GDP | 0.8015*** | | 1.0881*** | | 0.6128*** | |
| | (0.1740) | | (0.2104) | | (0.1255) | |
| CIT rate *j*, weighted tax havens | | 0.7678* | | 1.8420* | | 0.7106* |
| | | (0.4393) | | (1.006) | | (0.4127) |
| M1 (p value) | 0.043 | 0.015 | 0.044 | 0.039 | 0.041 | 0.023 |
| M2 (p value) | 0.927 | 0.612 | 0.827 | 0.984 | 0.417 | 0.362 |
| Over-identification | | | | | | |
| Hansen (p value) | 0.128 | 0.710 | 0.620 | 0.460 | 0.445 | 0.744 |
| Observations | 2189 | 2189 | 684 | 684 | 1505 | 1505 |
| Number of instruments | 31 | 45 | 31 | 29 | 31 | 45 |
| Number of countries | 136 | 131 | 29 | 29 | 102 | 102 |

Note: Dependent variable is statutory CIT rate. Full set control variables in all regressions. Robust standard errors, in parentheses; ***, **,* indicate significance at 1, 5, 10 percent.

1/ One step, robust, with instruments based on first lag of differences in the own CIT rate and weighted CIT rates of other countries (collapsed to avoid proliferation in the number of instruments) in levels equation, and second lags of their levels in the differenced equation.

## IV. CONCLUSIONS

The core question posed at the outset was whether base erosion, profit shifting and international tax competition really matter for developing countries. The empirical analysis here suggests, quite strongly, that they do—and, moreover, that they may well matter at least as much as for the advanced economies. Some of the results above suggest, for instance, that base spillovers from others' tax rates may be noticeably stronger for non-OECD countries than for OECD countries, and statistically more significant. And the signs are that these may operate less through effects on real investment decisions than through profit shifting. The revenue losses through avoidance activities associated with tax havens also seem to be more of a concern for non-OECD members; highly tentative estimates put them in the order of something over one point of GDP in the long run—a large amount, far larger relative to their total tax take than is the case in OECD members, and harder for them to replace from other sources.

These conclusions are to a very large degree tentative. The identification of spillover effects from tax havens is not easy, and the empirical characterization of 'haven' countries here does not fully capture the features making them attractive locations for profit shifting. Firm-level data, as is now routinely used to address international tax issues for advanced economies, would of course enable a much firmer grip on these issues. But such data remain very scarce for developing countries, forcing reliance, at least for now, on cruder approaches of the kind explored here.

The current policy debate on international tax issues is contentious and wide ranging, concerning not only specific problems within the current architecture—such as the challenges of implementing arms-length pricing and from treaty abuse—but also the appropriateness of that architecture itself.[24] The results here do not speak directly to appropriate reconfiguration of international tax design. They do suggest, however, that developing countries have a considerable stake in the outcome.

[24] For discussion of these wider issues, see for instance Devereux and Vella (2014) and IMF (2014).

## Appendix 1. Country Listing and Classification

**Low- and middle income countries:** Afghanistan*, Albania, Algeria*, Antigua and Barbuda*,1/, Argentina, Armenia, Bangladesh, Barbados1/, Republic of Belarus, Belize1/, Benin*, Bhutan*, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Burkina Faso*, Burundi*, Cambodia, Cameroon, Cabo Verde*, Central African Republic*, Chad*, Chile*,2/, China, Colombia, Comoros*, Republic of Congo*, Costa Rica1/, Côte d'Ivoire, Djibouti*, Dominica*,1/, Dominican Republic, Ecuador, Egypt, El Salvador, Republic of Equatorial Guinea*, Eritrea*, Ethiopia, Fiji, Gabon, The Gambia, Georgia, Ghana, Guatemala, Grenada*,1/, Guinea, Guinea-Bissau*, Guyana, Haiti, Honduras, Hungary2/, India, Indonesia, Islamic Republic of Iran, Iraq, Jamaica, Jordan1/, Kazakhstan, Kenya*, Kyrgyz Republic, Lao P.D.R.*, Latvia, Lebanon*,1/, Lesotho*, Liberia*,1/, Libya*, Lithuania, Former Yugoslav Republic of Macedonia, Madagascar*, Malaysia, Malawi, Maldives*,1/, Mali*, Mauritania*, Mauritius1/, Mexico*,2/, Moldova, Montenegro*, Mongolia*, Montserrat*,1/, Morocco, Mozambique, Myanmar*, Namibia, Nepal*, Nicaragua*, Nigeria, Niger*, Pakistan, Panama1/, Papua New Guinea, Paraguay, Peru, Philippines, Romania, Russian Federation, Rwanda*, São Tomé and Príncipe*, Senegal, Serbia*, Seychelles*,1/, Sierra Leone, Sri Lanka, Solomon Islands*, South Africa, St. Kitts and Nevis*,1/, St. Lucia1/, St. Vincent and the Grenadines1/, Swaziland, Syrian Arab Republic, Tajikistan*, Tanzania, Thailand, Togo*, Tonga*,1/, Tunisia, Turkey2/, Turkmenistan, Uganda, Ukraine, Uruguay Uzbekistan, Vanuatu*,1/, Venezuela, Vietnam, Yemen, Zambia, Zimbabwe.

**High income countries**: Australia2/, Austria2/, The Bahamas1/, Bahrain*,1/, Belgium2/, Canada2/, Croatia, Cyprus1/, Czech Republic2/, Denmark2/, Estonia2/, Finland2/, France2/, Germany2/, Greece2/, Hong Kong SAR1/, Iceland2/, Ireland1/,2/, Israel2/, Italy2/, Japan2/, Korea2/, Kuwait, Luxemburg1/,2/, Malta1/, Netherlands2/, New Zealand2/, Norway2/, Oman, Poland2/, Portugal2/, San Marino*,1/, Saudi Arabia*, Singapore1/, Slovak Republic2/, Slovenia2/, Spain2/, Sweden2/, Switzerland1/,2/, Trinidad and Tobago*, United Arab Emirates, United Kingdom2/, United States2/.

Note: Classification by income group follows the World Bank. Data on CIT rates are available for all countries listed; * indicates that data on CIT revenue (and hence base) are not available; 1/ indicates countries labeled, following Gravelle (2013) as 'havens'; 2/ indicates an OECD member.

## Appendix 2. Results Using Average Effective Tax Rates

Focusing again only on non-OECD members, Appendix Table A1 presents results on base and strategic rate spillovers (in columns (1)-(3) and (4)-(6) respectively) using average effective tax rates (AETR) instead of the statutory rates used in the text. The sample becomes much smaller, but still contains 43 developing countries. Data limitations mean that in this case a haven-weighted average of AETRs cannot be constructed; we use instead the unweighted average with a time trend.

The results for base spillovers are somewhat different from those in Table 4, one feature being a troubling insignificance of own rate effects. The insignificance of the haven-weighted rate is less surprising, since avoidance opportunities are expected to be associated with differences in statutory rates, not in AETRS. That the short-term base spillover effects when weighting AETRs abroad using GDP (column (1)) or by inverse-distance (column (3)) are larger and more significant than in Table 4 likely reflects that the AETR is indeed likely to better indicate the impact of tax considerations on the location of real investments.

On strategic rate spillovers, column (6) indicates no significant effect from inverse-distance weighted rates. For GDP-weighted (column (4)) and the unweighted average AETR (column (5)) the effect is significant, though less so than in Table 6 for the former. Signs of strategic rate-setting interactions thus seem somewhat stronger in relation to statutory tax rates than to AETRs.

**Appendix Table A1. Base and Strategic Rate Spillovers, using AETRs** 1/

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Base Spillover | | | Strategic Spillover | | |
| CIT Base, lagged | 0.9248*** | 0.7471*** | 0.7842*** | | | |
| | (0.0710) | (0.1872) | (0.1003) | | | |
| EATR *i* | 0.0083 | -0.1268* | -0.1423 | | | |
| | (0.0041) | (0.0747) | (0.1326) | | | |
| EATR *j*, weighted GDP | 0.2788** | | | 1.8971* | | |
| | (0.1461) | | | (1.0860) | | |
| EATR *j*, simple average | | 0.0668 | | | 0.3784* | |
| | | (0.0813) | | | (0.2123) | |
| EATR *j*, weighted inverse-distance | | | 0.2919*** | | | 0.1700 |
| | | | (0.0944) | | | (0.3319) |
| $\theta(\varphi)$ | 0.0011 | -0.5018 | -0.6596 | | | |
| | (0.0493) | (0.3826) | (0.7114) | | | |
| $\theta(\gamma)$ | 3.7095 | 0.2644 | 1.3529* | | | |
| | (4.1756) | (0.4392) | (0.8029) | | | |
| $\gamma = -\varphi$ (p value) | 0.060 | 0.502 | 0.242 | … | … | … |
| Restricted Coefficient | 0.013** | 0.1007* | 0.256*** | … | … | … |
| | (0.0061) | (0.0637) | (0.0895) | … | … | … |
| M1 (p value) | 0.049 | 0.033 | 0.038 | 0.008 | 0.008 | 0.034 |
| M2 (p value) | 0.485 | 0.414 | 0.495 | 0.118 | 0.127 | 0.343 |
| Over-identification | | | | | | |
| Hansen (p value) | 0.460 | 0.532 | 0.504 | 0.690 | 0.556 | 0.389 |
| Observations | 326 | 307 | 307 | 397 | 397 | 397 |
| Number of instruments | 42 | 44 | 41 | 27 | 25 | 27 |
| Number of countries | 38 | 37 | 37 | 41 | 41 | 41 |

Note: Dependent variable is the CIT base. Full set control variables and common time trend in all regressions. Robust standard errors, in parenthesis; ***(**,*) indicate significance at 1 (5, 10) percent.

1/ One step, robust, with instruments based on first lag of differences in the CIT tax base and CIT tax rates (collapsed to avoid proliferation in the number of instruments) in levels equation, and second lags of their levels in the differenced equation.

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