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Profit Shifting and Productivity Mismeasurement

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Abstract

This note identifies profit shifting in response to cross-country differences in corporate tax rates as a source of productivity mismeasurement. To quantify the magnitude of mismeasurement, the profit-shifting effect is isolated from other possible effects of corporate tax rates changes on real activity shifts. The empirical illustration suggests that the mismeasurement effect is quantitatively significant.

Keywords: productivity mismeasurement, income shifting, transfer pricing, corporate tax rates, STAN database.

JEL: D24, H26, O47.

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1. Introduction

The outburst of interest in tracking movements of productivity over time and in comparing productivity across countries has come on the heels of extraordinary economic developments in recent years. Sharp differences in productivity growth rates between the US and the EU, and between countries in the EU are being used to distinguish underlying sources of growth and the role of economic policy.[1] The measures of productivity therefore must be up to the task. Luckily, much attention has been paid in the latter part of the 1990s to the statistical quality of productivity measurement within countries, (e.g. Landefeld and Fraumeni (2000)), and comparisons between countries (Scarpetta et al. (2000)). In this note, profit shifting in response to changes in corporate tax rates is identified as a significant source of productivity mismeasurement. This overlooked source of mismeasurement is quantitatively relevant in OECD countries.

A nice conceptual method for uncovering potential problems in productivity measurement is Solow's invariance principle (see Hall, 1990). The invariance principle states that total factor productivity measures should be uncorrelated with indicators that on theoretical grounds are not expected to shift the production function. For example, the failure of the Solow residual to be uncorrelated with cyclical indicators spawned a considerable literature. Failure of the invariance principle can reconciled in different ways. First, the production technology assumed to derive the productivity measure can be modified to restore invariance.[2] Secondly, the failure of invariance can be traced to systematic mismeasurement of outputs or inputs.[3] Of course, a third way is to state that the failure of invariance is moot, or that there are indeed theoretical grounds for the indicator to affect productivity.[4]

In this note we isolate the mismeasurement effect of cross-country differences in corporate tax rates on productivity. International differences in corporate tax rates lead to income shifts purely on paper. Multinationals try to allocate revenues in countries with low corporate taxes and costs in countries with high corporate tax rates, all else equal. This causes reported nominal value added to differ from the economically meaningful measure. There are two major ways in which such pure-accounting shifts can take place. One is through the capital structure of multinational firms. For example, a subsidiary of a multinational in a low-tax

[1] For a few recent examples of theory and practice, see Ahn and Hemmings (2000), Durlauf and Quah (1999), or Ramey and Ramey (1995)

[2] In the literature on the pro-cyclical residual, the framework is modified, for example as in Bartelsman et al. (1994) who allow productive externalities.

[3] For example, this path was taken by Burnside and Eichenbaum (1996) and Basu and Kimball (1997) to explain pro-cyclical productivity residuals.

[4] For example, in the Real Business Cycle literature, researchers start with productivity movements as the cause of cyclicality in other indicators.

country may lend money to a subsidiary in a high-tax country, thereby boosting low-taxed profits by suppressing highly-taxed profits elsewhere. The other is when cross-border intra-firm deliveries of goods and services are not correctly priced. Although the OECD Model Tax Convention and the OECD Transfer Pricing Guidelines call for the use of the "arm's length principle" (i.e., to apply market prices for internal deliveries), in practice its application is often problematic. For many intra-firm transactions there exists no comparable outside market. For example, this is often the case for intellectual property developed by one part of the company and used by other parts in other countries. The empirical literature suggests that this source of income shifting is quantitatively important, for example, see Hines and Rice (1994) and Grubert and Slemrod (1998) for the U.S. and Bartelsman and Beetsma (2000) for OECD countries. For a discussion of the effect for individual firms, see Birnie (1996).

The remainder of this note is structured as follows. Section 2 shows how corporate tax differences can affect measured productivity. Section 3 illustrates how productivity growth can be corrected for mismeasurement caused by profit shifting and discusses the data. Finally, Section 4 concludes this note.

2. Corporate taxes and productivity mismeasurement

Income shifting causes differences between reported income and the "true" income generated by economic activity. Revenues are underreported (overreported) in countries with relatively high (low) tax rates, because the firm claims lower- (higher-) than-market prices for intra-firm international shipments of goods and services. Consequently, reported nominal value added (NVA, revenue less intermediate purchases) in a country is negatively affected by the level of its corporate tax rate relative to trading partners. Profit shifting causes statistics on nominal value added collected by the tax authorities or statistical offices to be measured with error:

$$NVA = P^{tr} Q^{*},$$

where Q^{*} is *actual* real value added and P^{tr} is the implicit (and unobserved) price defined by this expression. It differs by a factor from the market price, or arms-length price (P^{*}):

$$P^{tr} = P^{*} e(\tau^{D}), \text{where } \frac{\partial e}{\partial \tau^{D}} < 0, \qquad (2.1)$$

and where τ^{D} is the difference between the tax rate in this country and the country with which intra-firm trade takes place.

A country's statistical office uses proper price quotes on market transactions, so that price statistics and actual market, or arms-length, prices coincide. Hence, P^* is also the official deflator. Real value added *statistics* (Q) as computed by the statistical office are thus contaminated with mismeasurement from income shifting, and therefore differ from actual real value added (Q^*) by the factor $e(\tau^D)$:

$$Q = \frac{\text{NVA}}{P^*} = Q^* e\left(\tau^D\right). \tag{2.2}$$

Suppose that actual production takes place according to:

$$Q^* = AF(K, L), \tag{2.3}$$

where K is capital and L is labor input, and A is unobserved (by the econometrician) total factor productivity. Upon combining (2.2) and (2.3) one obtains the *observed* TFP level

$$\text{TFP} \equiv \frac{Q}{F(K, L)} = Ae\left(\tau^D\right), \tag{2.4}$$

which is correlated with relative tax rates.

3. Quantification

While the primary interest for researchers is in the unobserved term A, the data provided by the statistical office only allow one to compute the term on the left-hand side of (2.4). However, if we are able to somehow estimate $e\left(\tau^D\right)$, we can construct the series for actual total factor productivity from the observed productivity series.

To be clear, we do not make an attempt to assess the real effects of corporate taxes on actual TFP, or A. One could presumably write down a model where technology and taxes are correlated, for example because technology is embodied in new capital goods and accrues to the purchaser as an externality. In this case, a correlation between taxes and observed productivity would not distinguish the magnitude of $e(\tau)$ term, because it also reflects the effect of taxes on A. Similarly, if one has theoretical priors about a link between taxes on productivity, for example because higher marginal after-tax profit rates create an incentive to reduce x-inefficiency, this would prohibit us from distinguishing $e(\tau)$. As we show below, we isolate the mismeasurement effect, but thereby lose the ability to say something about any direct effects of taxes on actual productivity.

3.1. Identification

The basic insight for identification of the mismeasurement of productivity through profit-shifting is to view the problem as an errors-in-variables problem in estimating a production function. The strategy is to disentangle the mismeasurement component and the productivity component.[5] Analogous to the approach of Roeger (1995) for disentangling mark-ups and productivity movements, we take a ratio of nominal output and nominal input expenses, in order to cancel out the unobserved productivity term.

Multinationals hire labor until the wage equals the marginal revenue product, valued at market prices (see Bartelsman and Beetsma, 2000):

$$w = P^* \frac{\partial Q^*}{\partial L}.$$

With a Cobb-Douglas technology and constant returns to scale, in symbols $Q^* = AF(K, L) = AK^{1-\alpha}L^{\alpha}$, we get the following relationship between the observed (reciprocal of the) labor share and the factor $e(\tau^D)$:

$$\frac{P^*Q}{wL} = \frac{1}{\alpha}e(\tau^D). \tag{3.1}$$

Note that the unobserved productivity term A cancels out. We refer to the left-hand side of (3.1) as the "value-labor ratio". The advantage of using (3.1) in the empirical analysis, is that we control for the effect that tax rates may have on the level of economic activity. Under Cobb-Douglas, the level of economic activity and the wage-rental ratio will not affect the labor share of income. The latter is no longer the case for a constant elasticity of substitution (CES) production technology, where an increase in the cost of capital as a result of tax rate changes implies a substitution towards labor. With a CES production technology, in symbols $F(K, L) = [\delta K^{\rho} + (1 - \delta) L^{\rho}]^{1/\rho}$, one has:

$$\frac{PQ}{wL} = [1 + \zeta^{1/(\rho-1)}(\frac{\tilde{r}}{w})^{\rho/(\rho-1)}]e(\tau^D), \tag{3.2}$$

where $\zeta \equiv [\delta/(1-\delta)]$ and $\tilde{r}$ denotes the tax-dependent Jorgenson-Hall user cost of capital. Because the functional relation between taxes and the user cost of capital is well known, $\tilde{r}$ can be constructed from the available data, and only the CES parameters and the function $e(\tau^D)$ need to be estimated.

[5] For an overview of some of the identification problems in estimating productivity, see Bartelsman and Doms (2000).

3.2. Econometric specification

The functional form of the transfer-pricing response to taxes $e(\tau^D)$ is assumed to resemble a mark-up which varies linearly in the deviation between the country-specific and the average tax rates. Equation (3.1) is used as the basis for the following estimating equation:

$$V_{ijt} = c_{cst} * (1 + \gamma_c \tau_{ijt}^D) + \epsilon_{ijt}, \tag{3.3}$$

where V_{ijt} is the observed value-labor ratio in country i, sector j and time period t, and where

$$c_{cst} = c + \sum_{d=2}^{N_c} c_d^c (I_{d,ijt}^c - I_{1,ijt}^c) + \sum_{d=2}^{N_s} c_d^s (I_{d,ijt}^s - I_{1,ijt}^s) + \sum_{d=2}^{N_\tau} c_d^\tau (I_{d,ijt}^\tau - I_{1,ijt}^\tau), \tag{3.4}$$

where $I_{d,ijt}^c$ is an indicator that equals 1 if observation ijt belongs to country d, and equals 0 otherwise (N_c is the number of countries in our sample); $I_{d,ijt}^s$ is an indicator that equals 1 if observation ijt belongs to sector d, and equals 0 otherwise (N_s is the number of sectors); and $I_{d,ijt}^\tau$ is an indicator that equals 1 if observation ijt belongs to year d, and equals 0 otherwise (N_τ is the number of years). Further, τ_{ijt}^D (measured in *percentage points*) is the difference between the headline corporate tax rate in sector j of country i at time t from the weighted average of headline taxes of all countries in the sample.[6] Although profit shifting may be affected by the presence of other taxes and cross-country differences between them, at the margin the gain from shifting an additional dollar should for a large part be determined by the difference in headline corporate tax rates. Finally, the response coefficient γ_c will be allowed to vary across countries. The rationale for having γ_c to vary over the countries is that countries may differ in the enforcement of the transfer pricing rules. In addition, in some countries economic activity may be relatively more concentrated than in other countries in sectors where the scope for profit shifting is larger.

The estimating equation for the CES production function is based on equation (3.2) :

$$V_{ijt} = [1 + c_{cst}^{1/(\rho-1)} (\frac{\tilde{r}_{ijt}}{w_{ijt}})^{\rho/(\rho-1)}](1 + \gamma_c \tau_{ijt}^D) + \epsilon_{ijt}, \tag{3.5}$$

with c_{cst} as given above. The user cost of capital is given by $\tilde{r}_{ijt} = P_{I,it} \frac{r_{it} + \theta - \dot{q}_{it}}{1 - \tau_{it}} (1 - \tau_{Z,it})$, where r is the long-term interest rate, P_I is the investment deflator, θ is the

[6] For each sector, the average tax rate is computed using sectoral production as relative weights. For this reason, $\bar{\tau}^D$ varies slightly between sectors in a country. The consideration was that transfer-pricing takes place between affiliates within a sector, owing to taxes differing from those in relevant countries. The weighting scheme, however, hardly influences our results.

depreciation rate, $\dot{q}$ is the expected appreciation of capital, τ is the corporate tax rate and τ_Z is the present discounted tax value of depreciation deductions. In the empirical work,τ_Z is calculated assuming static expections on future tax rates. Furthermore, we use a constant discount rate (6%), and geometric depreciation ($\theta = 0.08$).

3.3. Empirical correction

Now we will illustrate how to obtain an estimate for the mismeasurement effect on productivity growth. We take our data from three sources. Data on labor compensation and value-added are obtained from the OECD's "Structural Analysis Database" (STAN). This is a sectoral database, which comprises most of the OECD countries. We include 16 countries and 15 sectors.[7] Further, we take the long-term interest rate and the price deflator for investment from the annual economic indicators database of the OECD. Finally, we obtain headline corporate tax rates from various issues of PriceWaterhouseCoopers' *International Tax Summaries.* The maximum length of our sample period is 1979-1997.

Table 1 presents the estimates of γ_c using either (3.3) or (3.5), with dummies to get rid of country-, sector- and time-specific fixed effects. We allow γ_c to vary over the individual countries and report its cross-country average estimate $\tilde{\gamma}_c$. A Cobb-Douglas production function yields a statistically significant estimate of $\tilde{\gamma}_c = -0.0052$, which indicates that a one-percentage point increase in the relative corporate tax rate reduces the value-labor ratio by 0.5 percent.[8] Using a CES production function yields a very similar estimate of γ_c. Moreover, the estimate for ρ results in a point estimate of the elasticity of substitution between capital and labor of $1/(1-\hat{\rho}) = 1.04$, which is hardly different from the substitution elasticity for a Cobb-Douglas production function. Therefore, the ensuing computations are based on the Cobb-Douglas specification.

To compute how measured productivity growth is affected by income shifting induced by corporate tax rate differences, observe that

$$[e\,(\hat{\tau^D})] \quad = \quad \ln\left[\tilde{c}(1+\tilde{\gamma}_c\tau^D)\right] - \ln\left[\tilde{c}(1+\tilde{\gamma}_c\tau^D_{-1})\right]$$

[7]The countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Portugal, Spain, Sweden, the United Kingdom and the United States. The sectors comprise almost the entire manufacturing industry. Excluded are "Petrol refineries and products" and "Rubber and plastics products". Presently, the OECD is working on a new release of the STAN database. In the next release, the data will be available for all sectors of the economy. Furthermore, estimates of productive capital stocks will be available for most sectors in most countries.

[8]This is the average effect across countries. In the regression a deviation of this average was computed for all but one country.

$$= \tilde{\gamma}_c \left(\tau^D - \tau^D_{-1} \right). \tag{3.6}$$

where $\tilde{c}$ is the estimate of c in (3.4). Because a relative change in the corporate tax rate only causes a *shift* in income, according to the framework set out above we should observe a spike (positive or negative) in the productivity growth statistics whenever such a relative tax rate change takes place. However, productivity growth time series do not reveal such clearly discernible peaks around changes in corporate tax rates. One reason is that the volatility in measured productivity growth caused by other factors may dominate the effect of profit shifting. Another reason is that, in reality, pure-paper income shifts may take some time to materialize. For example, the amount of income shifting is likely to be connected to the size of the real acitivity shift brought about by the tax rate changes.[9] Real activity shifts usually do not take place instantaneously, because physical (dis)investments need to be made and workers need to be hired or fired. Therefore, the sample period for which we want to illustrate the effect of profit shifting on measured productivity growth needs to include some years after a large relative tax change. Hence, when productivity growth is measured as a yearly average over a T-year sample period, the correction for income shifting becomes $\tilde{\gamma}_c \left(\tau^D_T - \tau^D_0 \right) /T$, with τ^D_T the tax rate difference at the end and τ^D_0 the tax rate difference at the start of the sample period.

Quite a few countries in our sample experienced large declines in their corporate tax rates in the 1980s. However, the timing of the drops varied, and there was significant variation between countries and over time in relative rates. For example, in the U.S. the tax rate fell from 1.56 percentage points above our sample OECD average in 1979 to 4.72 percentage points below the average in 1989, reflecting movements in the average and a decline in the U.S. headline corporate tax rate from 46% to 34% in 1987. In Germany, the relative corporate tax rate rose from 11.6 to 17.3 percentage points from 1979 to 1989. The changes in relative tax rates along with our estimate $\tilde{\gamma}_c$ can provide a correction to TFP or labor productivity growth. For example, the annual U.S. labor productivity growth rate in the manufacturing sector from 1979 through 1989 of 2.97% as reported in Scarpetta et al. (2000) overstates the actual rate of 2.64% owing to mismeasurement. Similarly, the German growth rate should be 1.55% rather than the reported rate of 1.26%.

[9] One would expect that the amount of income that can be shifted from the residence country to a low-tax country, without causing the suspicion of the residence country's tax authorities, is connected to the amount of productive activity in the low-tax country; more productive activity allows for more intra-firm trade and, for a given shift in the reported price for which a unit of a product is traded across borders, more income shifting can take place.

4. Concluding remarks

In this note we have shown how cross-border profit-shifting as a result of differences in corporate tax rates can cause productivity growth to be mismeasured. To quantify the mismeasurement effect, we had to disentangle it from the effect of corporate tax rate changes on real activity shifts. Our empirical illustration suggests that the mismeasurement effect is non-negligible.

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Table 1: Parameter estimates

equation:		$\tilde{c}$	$\tilde{\gamma}$	$\tilde{\rho}$	R^2	SSE
(3.3)	Cobb-Douglas	1.61	$-.0052$		0.49	0.13
		(.0097)	(.0012)			
(3.5)	CES	3.61	$-.0049$	0.04	0.59	0.11
		(.45)	(.0010)	(.0092)		

Notes: (1) $\tilde{c}$ = estimate of c, $\tilde{\gamma}$ = average estimate of γ (where γ is allowed to vary over the countries),
$\tilde{\rho}$ = estimate of ρ, SSE = standard error of regression.
(2) Numbers in brackets denote the standard errors. All the estimates are highly significant at convential confidence levels.
(3) Regressions include country, sector and time dummies.
(4) Numbers of observations is 4100.
(5) Maximum sample period is 1979-1997.