3

Empirical Models of International Capital-tax Competition

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Abstract

Many academic and casual observers contend that the dramatic post-1970s rise in international capital mobility and the steadily upward postwar trend in trade integration, by sharpening capital's threat against domestic governments to flee 'excessive and inefficient' taxation, has forced and will continue to force welfare/tax-state retrenchment and tax-burden shifts away from more mobile capital (especially financial capital) and toward less mobile labor (especially manual labor). Several important recent studies of the comparative and international political economy of policy change over this period challenge such claims, whereas others find more support. We offer a brief review and comparison of these arguments, emphasizing that all imply a strategic interdependence in fiscal policymaking that, in turn, implies a spatial interdependence in tax-policy data, which these previous studies tended to ignore. We then briefly summarize our own preliminary explorations of alternative strategies for estimating empirical models of such interdependent processes and, finally, we explore the empirical record regarding globalization and tax competition, applying the spatial-lag model in a reanalysis of the capital-tax regressions in Hays (2003).

3.1 Introduction

This paper studies globalization, i.e. international economic integration, and capital taxation, emphasizing the implied strategic dependence in fiscal policymaking and the resultant spatial interdependence of fiscal-policy data. Many academic and casual observers argue that the dramatic post-1972 rise in global capital mobility and the steady postwar rise in trade integration sharpen capital's threat against domestic governments to flee 'excessive and inefficient' taxation and public policies. This, the standard view holds, has forced and will continue to force welfare- and tax-state retrenchment and tax-burden shifts from more mobile capital (especially financial) toward less mobile labor (especially skilled manual).

Several important studies of the comparative and international political economy of tax and welfare policies over this era have recently challenged such claims on at least four distinct bases. Garrett (1998) argued that certain combinations of left government with social-welfare, active-labor-market, coordinated-bargaining, and related policies can be as or more efficient than neoliberal state-minimalism and conservative government and, therefore, that capital will not flee such efficient combinations. Boix (1998) argued that public (human and physical) capital-investment strategies comprise an alternative to neoliberal minimalism that is sufficiently efficient economically to retain and possibly attract capital and politically effective enough to maintain left electoral competitiveness. Hall and Soskice (2001) argued that complex national networks of political–economic institutions

confer *comparative* advantages in differing productive activities, which, as Mosher and Franzese (2002) elaborated, implies that, *if international tax competition remains sufficiently muted*, capital mobility and trade integration would spur institutional and policy specialization, which, in this context, means cross-national welfare/tax-state variation rather than convergence or global retrenchment. Swank (2002) argued that the institutional structure of the polity and of the welfare/tax system itself shape domestic policy responses to capital (and trade) integration. We review such arguments and offer a preliminary evaluation, specifying empirical models that, unlike these and other previous efforts, embody the spatial relationships central to such diffusion processes.

Two recent studies (Hays, 2003; Basinger and Hallerberg, 2004), however, do recognize the strategic interdependence implicit in tax-competition arguments and incorporate the implied spatial interdependence into their empirical analyses.[1] As we show elsewhere (Franzese and Hays, 2004, 2006) and will summarize later, though, least-squares estimation of such spatial empirical models (S-OLS) suffers important statistical flaws that, in particular, jeopardize any conclusions drawn from hypothesis tests related to the crucial parameter, the coefficient on the 'spatial lag', which gauges the strength of interdependence. We reanalyze Hays's (2003) model by an alternative estimation strategy, spatial two-stage-least-squares instrumental variables (S-2SLS-IV) that, in our previous Monte Carlo experiments, produced unbiased hypothesis tests.

3.2 Globalization, tax competition, and convergence

In theory, strong inter-jurisdictional competition undermines the tax-policy autonomy of individual tax authorities, inducing tax rates to converge, especially those levied upon more mobile assets. Such inter-jurisdiction competition intensifies as capital becomes more liquid and more mobile across borders. Indeed, many scholars of domestic and international fiscal competition (e.g. Zodrow and Mieszkowski, 1986; Wilson, 1986, 1999; Wildasin, 1989; Oates, 2001) expect such intense inter-jurisdiction competition to engender a virtually unmitigated race to some (*ill-defined*: See below) bottom. As a central exemplar, most scholarly and casual observers see the striking post-1970s rise in international capital mobility and steady postwar increase in trade integration as forcing welfare- and tax-state retrenchment and a shift in tax-burden incidence from relatively mobile (e.g. capital, especially financial capital) toward more immobile (e.g. labor, especially less-flexibly-specialized types).[2] Growing capital-market integration and

asset mobility across jurisdictions enhances such pressures, the argument holds, by sharpening capital's threat against domestic governments to flee 'excessive and inefficient' welfare and tax systems.

Several notable recent studies of the comparative and international political economy of policy change over this period challenge these claims. First, empirically, some contest whether *globalization* in general and capital mobility in particular have actually significantly constrained public policies broadly and capital-tax policy specifically. Hines (1999), after reviewing the empirical economics literature, concluded that national tax systems affect the investment location decisions of multinational corporations and firms do seize opportunities to avoid taxes. Rodrik (1997), Dehejia and Genschel (1999), Genschel (2001), and others argued that this has increasingly constrained governments' policy-latitude in recent years. Quinn (1997), Swank (1998, 2002), Swank and Steinmo (2002), Garrett and Mitchell (2001), and others, however, did not find these trends to have constrained governments' tax policies much or at all. The theoretical explanation for the latter kinds of results, occasionally implicit, seems that other cross-national differences also importantly affect investment-location decisions, affording governments some room to maneuver. Hines (1999, p. 308), for example, found commercial, regulatory, and other policies, and labor-market institutions, intermediate-supply availability, and final-market proximity, among other factors, to be key in corporate investment-location decisions. Moreover, other factors than capital mobility affect governments' tax policies. For example, Swank (2002, see pp. 252–256 in particular) argued that corporate and capital tax rates depend on funding requirements of programmatic outlays, macroeconomic factors like inflation and economic growth, and partisan politics. Controlling for such factors, he found little relationship between taxation and capital mobility.

On closer inspection, these recent challenges to simplistic *globalization-induces-welfare/tax-state-retrenchment* views have at least four distinct bases. Garrett (1998) argued that certain combinations of left government and social-welfare, active-labor-market, and related policies with coordinated bargaining can be as or more efficient than neoliberal state-minimalism and conservative government. Therefore, he argues, capital will not flee such efficient combinations. Boix (1998) argued that public human- and physical-capital investment strategies comprise an alternative to neoliberal minimalism that is sufficiently efficient economically to retain, and perhaps attract, capital, and politically effective enough to maintain left electoral competitiveness. Hall et al. (2001) argued that complex national networks of political–economic institutions confer *comparative* advantages in differing productive activities, which, as Mosher and Franzese (2002)

elaborated, implies capital mobility and trade integration could (*if international tax competition remains sufficiently muted*: See below) spur institutional and policy specialization, which would imply persistent welfare/tax-system variation or even divergence rather than convergence or global retrenchment. These three views fundamentally question whether international economic integration actually creates economic pressures to retreat from welfare/tax-state commitments (or at least whether all aspects of globalization do so, so strongly: See below).

Swank's (2002) argument that the institutional structures of the polity and of the welfare system itself shape the domestic policy response to integration represents a fourth basis for challenge. His view does not fundamentally challenge claims of the exclusively superior macroeconomic efficiency of neoliberal minimalism but, rather, stresses the primacy of domestic political conditions – the policymaking access, cohesion and organization, and relative power of contending pro- and anti-welfare/tax interests – in determining the direction and magnitude of welfare/tax-policy reactions to economic integration. Specifically, he argued and found that inclusive electoral institutions, social-corporatist interest representation and policymaking, centralized political authority, and universal welfare systems relatively favor the political access and potency of pro-welfare/public-policy interests and bolster supportive social norms in the domestic political struggle over the policy response to integration. The opposite conditions favor anti-tax/ welfare interests and norms in this struggle. Capital mobility and globalization therefore induce increased welfare/tax-state largesse in previously generous states and retrenchment in tight ones – i.e. divergence rather than convergence. Swank's approach is, thus, the most directly and thoroughly political of these critiques. It is also perhaps the most thoroughly explored empirically, offering comparative-historical statistical and qualitative analyses of six alternative versions of the *globalization-induces-retrenchment* thesis: A simple version (a regression including one of five capital-openness measures), and five others he terms the *run-to-the-bottom* (capital openness times lagged welfare-policy), *convergence* (capital openness times the gap from own to cross-country mean welfare-policy), *nonlinear* (capital openness and its square), *trade-and-capital-openness* (their product), *capital-openness-times-fiscal-stress* (deficits times capital openness), and *capital-flight* (net foreign direct investment) versions. He found little support for any globalization-induces-retrenchment argument and, indeed, some indications that capital mobility tends on average to enhance welfare effort (perhaps supporting those stressing its effect in increasing popular demand for social insurance against global risks).[3]

Basinger and Hallerberg (2004), in a sense, take the implied next step of Swank's central point. Swank stressed the domestic political and political–economic

institutions and structures of interest that shape governments' policy responses to economic integration. It then follows, however, as Basinger and Hallerberg (2004, p. 261) summarize, '[if] countries with higher political costs are less likely themselves to enact reforms, [then this] also reduces competing countries' incentives to reform regardless of their own political costs'. That is, the magnitude of the tax-competition pressures that economic integration places upon one government's fiscal policies depend upon the policy choices of its competitors, which is precisely the strategic interdependence that we emphasize here as well.

Such critiques underscore that the *bottom* toward which globalization and capital mobility may push tax-competing states may not be that of neoliberal minimalism. Insofar as alternative economic advantages allow some states to retain higher tax rates, or insofar as restraining political conditions prevent some from reaching neoliberal minimum, the competitive pressures on all states diminish, more so, of course, the more economically integrated and important are those states whose domestic political–economic conditions allow such maneuvering room or raise such constraints. Furthermore, if, as Mosher and Franzese (2002) suggest, national economic-policy differences contribute to *comparative* advantages – which, if they do, they do regardless of their *absolute* efficiency – then both trade and global *fixed-capital* integration would actually enhance economic pressures toward specialization, i.e. divergence and not convergence. From this view, international *liquid-capital* mobility alone, through the tax competition it engenders, produces whatever 'races' may occur. In this case, interestingly, such competitive races would occur regardless and independent of the efficiency of the tax systems in question or of the public policies they support. Furthermore, as both Hays (2003) and Basinger and Hallerberg (2004) stressed, the race need not be to the *bottom*; Rather, the competitiveness and the destination of the race depend on the constellation of domestic political–economic conditions present in, and the economic integration of, the international system. Conversely, as Mosher and Franzese (2002) emphasized, zero offers no inherent *bottom* to such tax-cut races as may occur. In the competition for liquid portfolio capital specifically, governments would always have incentives to cut taxes further, perhaps deep into subsidy; Only their abilities to tax other less liquid and/or mobile assets and to borrow limit (in an internationally interdependent manner, as just noted) those races.

Thus, international tax-competition arguments, in any of their conventional forms and throughout each of these critiques, imply cross-national (i.e. spatial) interdependence in the rates of capital taxation. Whatever pressures upon domestic policymaking may derive from rising (liquid-portfolio) capital mobility,

their nature and magnitude will depend on the constellation of tax (and broader economic) systems with which the domestic economy competes.

3.3 A stylized theoretical model of capital-tax competition

We leverage Persson and Tabellini's (2000, Chapter 12) formal–theoretical model to demonstrate further that tax competition implies spatial interdependence. The model's essential elements are as follows. In two jurisdictions (i.e. countries), denote the domestic and foreign capital-tax rates as τ_k and τ_k^*. Individuals can invest in either country, but foreign investment incurs *mobility costs*. Taxation follows the source (not the residence) principle. Governments use revenues from taxes levied on capital and labor to fund a fixed amount of spending.[4] Individuals differ in their relative labor-to-capital endowment, denoted e^i, and make labor leisure, l and x, and savings investment, $s = k + f$ (k = domestic; f = foreign), decisions to maximize quasi-linear utility, $\omega = U(c_1) + c_2 + V(x)$, over leisure and consumption and in the model's two periods, c_1 and c_2, subject to a time constraint, $1 + e^i = l + x$, and budget constraints in each period, $1 - e^i = c_1 + k + f + \equiv c_1 + s$ and $c_2 = (1 - \tau_k)k + (1 - \tau_k^*)f - M(f) + (1 - \tau_l)l$.

The equilibrium economic choices of citizens i in this model are as follows:

$$s = S(\tau_k) = 1 - U_c^{-1}(1 - \tau_k) \tag{3.1}$$

$$f = F(\tau_k, \tau_k^*) = M_f^{-1}(\tau_k - \tau_k^*) \tag{3.2}$$

$$k = K(\tau_k, \tau_k^*) = S(\tau_k) - F(\tau_k, \tau_k^*). \tag{3.3}$$

With labor, $L(\tau_l)$, leisure, x, and consumption, c_1, c_2, implicitly given by these conditions, this leaves individuals with indirect utility, W, defined over the policy variables, tax rates, of:

$$\begin{aligned} W(\tau_l, \tau_k) = {} & U\{1 - S(\tau_k)\} + (1 - \tau_k)S(\tau_k) + (\tau_k - \tau_k^*)F(\tau_k, \tau_k^*) - M\{F(\tau_k, \tau_k^*)\} \\ & + (1 - \tau_l)L(\tau_l) + V\{1 - L(\tau_l)\}. \end{aligned} \tag{3.4}$$

Facing an electorate with these preferences over taxes, using a Besley–Coate (1997) citizen-candidate model wherein running for office is costly and citizens choose whether to enter the race by an expected-utility calculation, some citizen

candidate will win and set tax rates to maximize his or her own welfare. The model's stages are: (1) Elections occur in both countries; (2) Elected citizen-candidates set their respective countries' tax rates; (3) All private economic decisions are made. In this case, the candidate who enters and wins will be the one with endowment e^p such that s/he desires to implement the following *Modified Ramsey Rule*:

$$\frac{S(\tau_k^p) - e^p}{S(\tau_k^p)}[1 + \varepsilon_l(\tau_k^p)] = \frac{L(\tau_l^p) + e^p}{L(\tau_l^p)}\left[1 + \frac{S_\tau(\tau_k^p) + 2F_\tau^*(\tau_k^{p^*}, \tau_k^p)\tau_k}{S_\tau(\tau_k^p)}\right]. \quad (3.5)$$

Equation (3.5) gives the optimal capital-tax-rate policy for the domestic policymaker to choose, which, as one can see, is a function of the capital tax-rate chosen abroad. The game is symmetric, so the optimal capital tax-rate for the foreign policymaker to choose looks identical from his or her point of view and, importantly, depends on the capital tax-rate chosen domestically. That is, equation (3.5) gives best-response functions $\tau_k = T(e^p, \tau_k^*)$ and $\tau_k^* = T^*(e^p, \tau_k)$ for the foreign and domestic policymaker respectively. In words, the domestic (foreign) capital-tax rate depends on the domestic (foreign) policymaker's labor-capital endowment and the foreign (domestic) capital tax rate – i.e. capital taxes are strategically interdependent. The slope of these functions, $\partial T/\partial \tau_k^*$ and $\partial T^*/\partial \tau_k$, can be either positive or negative. An increase in foreign tax rates induces capital flow into the domestic economy, but the domestic policymaker may use the increased tax base to lower tax rates or to raise them (the latter to seize the greater revenue opportunities created by the decreased elasticity of this base). Figure 3.1 plots these reaction functions assuming that both slope positively. The illustrated comparative static shows an increase in the domestic policymaker's labor-capital endowment. This change shifts the function T outward, raising the equilibrium capital-tax rate in both countries.

Although formal tax-competition models, like Persson and Tabellini's (or Hays' or Basinger and Hallerberg's), clearly demonstrate the strategic ('spatial'[5]) interdependence of capital taxes, as any of the alternative arguments reviewed above would also imply, very few scholars have empirically modeled that interdependence directly. Not all tax/welfare-state retrenchment arguments, however, necessarily involve tax competition. Iversen and Cusack (2000), for example, argue that structural change in the labor force, specifically deindustrialization, is the primary force pushing welfare/tax-state retrenchment. Pierson (2001) concurs in part, but also emphasizes *path dependence* (technically, state dependence), namely the accumulation and entrenchment of interests (or their absence) behind

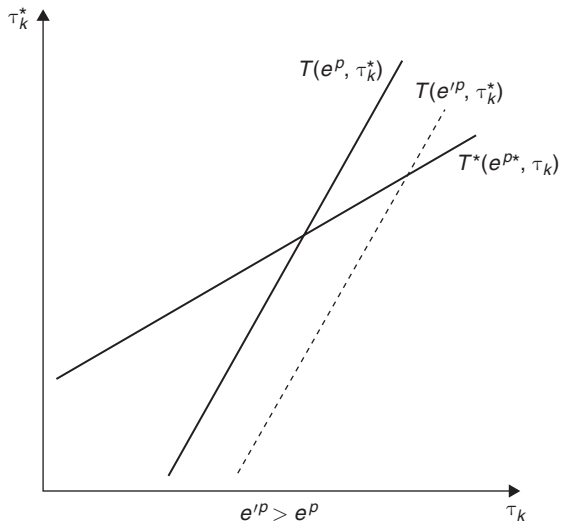

Figure 3.1 Best response functions. Reprinted from Persson, T. and Tabellini, G. (2000). *Political Economics: Explaining Economic Policy*, p. 334, by permission of The MIT Press, Cambridge, MA. © 2000 Massachusetts Institute of Technology)

welfare/tax-state policies and institutions. Rodrik (1998), and Cameron (1978) before him, stressed instead the added demand from some domestic interests for certain social policies that increased economic exposure would engender. Such forces – labor-force structural change, domestic-interest entrenchment and/or change – may be related to, or even partly caused by, aspects of globalization, but ultimately these are domestic arguments, or arguments about domestic factors that modify responses to *exogenous* external trends, and therefore do not by themselves imply a strategic interdependence among policy choices, as do the tax-competition arguments reviewed above.

We term the former sorts of 'domestic factors' or 'exogenous external' or 'domestic factors–conditional responses to exogenous external' approaches *Open Economy–Comparative Political Economy* (OE-CPE), and the latter, pure tax-competition arguments exemplify the (internationally) strategic-interdependence approaches we term *International Interdependence–Political Economy* (II-PE). Of course, the two are easily combined in *(Open-Economy) Comparative and International Political Economy* (C&IPE) models that reflect both domestic factors and/or domestically modified responses to exogenous-external conditions on the one hand and international interdependence on the other. We (re-)analyze one such C&IPE empirical model of globalization and capital-tax competition (Hays, 2003)

in the section after next, but first we explain the serious econometric challenges to estimating and, a fortiori, distinguishing these alternatives and some (partially successful) approaches to surmounting these challenges.

3.4 Econometric issues in estimating C&IPE empirical models from spatially interdependent data

Open-economy CPE explicitly recognizes the potentially large effects of external conditions on domestic political and economic outcomes, often emphasizing how domestic institutions, structure, and contexts shape the degree and nature of domestic exposure to such external (i.e. foreign or international) conditions and/or moderate the domestic policy and outcome responses thereto. This produces characteristic theoretical and empirical models of the following sort:

$$\mathbf{y}_{it} = \xi_{it}\boldsymbol{\beta}_0 + \eta_t\boldsymbol{\beta}_1 + (\xi_{it} \cdot \eta_t)\,\boldsymbol{\beta}_3 + \varepsilon_{it}. \tag{3.6}$$

In equation (3.6), the incidence, impact, and/or effects of global conditions, η_t, on domestic policies/outcomes, $\boldsymbol{y}_{it}$, are conditioned by domestic institutional–structural–contextual factors, ξ_{it}, and so differ across spatial units (countries). Welfare/tax-state retrenchment examples of such an approach include the aforementioned Iversen–Cusack or Cameron–Rodrik arguments. The exogenous-external conditions, η_t, in those cases might reflect technological or other progress in production, shipping, or financial processes.[6] The domestic institutional, structural, or contextual conditions, ξ_{it}, in these examples that affect policies/outcomes and/or moderate domestic policy/outcome responses to these exogenous-external trends might include union density, existing industrial structure, and partisan electoral competitiveness. In empirical specifications of such OE-CPE models, researchers would typically leave to FGLS or PCSE 'corrections' any spatial correlation distinct from that induced by the common or correlated responses to the *exogenous*-external conditions.

II-PE approaches and models, contrarily, explicitly incorporate the interdependence of domestic and foreign policies/outcomes, as implied, for example, by tax competition. C&IPE combines the two to produce characteristic theoretical and empirical models of the following sort:

$$\mathbf{y}_{it} = \rho\sum_{j\neq i} w_{ij}\mathbf{y}_{j,t} + \xi_{it}\boldsymbol{\beta}_0 + \eta_t\boldsymbol{\beta}_1 + (\xi_{it} \cdot \eta_t)\,\boldsymbol{\beta}_3 + \varepsilon_{it}, \tag{3.7}$$

where $\boldsymbol{y}_{j,t}$, the outcomes in the other ($j \neq i$) units in some manner (given by ρw_{ij}) directly affect the outcome in unit i. Note that w_{ij} reflects the degree of connection from j to i, and ρ reflects the impact of the outcomes in the other ($j \neq i$) units, as weighted by w_{ij}, on the outcome in i. In the substantive venue of tax competition, for example, the w_{ij} could gauge the similarity or complementarity i's and j's economies or of their (capital or goods-and-services) trade bundles. The rest of the right-hand-side model reflects the domestic political economy, including the domestic-context-conditional effects of exogenous external conditions as described in the OE-CPE model (3.6).

Econometrically, as we summarize below (working from Franzese and Hays, 2004, 2006), obtaining 'good' (unbiased, consistent, efficient) estimates of coefficients and standard errors in such C&IPE models and distinguishing OE-CPE processes from II-PE processes are *not* straightforward. The first and foremost considerations are the relative and absolute theoretical and empirical precisions of the alternative OE-CPE and II-PE parts of the model, i.e. the *interdependence* parts and the *common, correlated, or domestic-context-conditional responses to common, correlated, or domestic-context-conditioned exogenous-external factors* (henceforth *common-conditions*) parts. To elaborate: The relative and absolute accuracy and power with which the spatial-lag weights, w_{ij}, reflect and can gain leverage upon the actual *interdependence* mechanisms operating and with which the domestic and exogenous-external parts of the model can reflect and gain leverage upon the *common-conditions* alternatives critically affect the empirical attempt to distinguish and evaluate their relative strength because the two mechanisms produce similar effects so that inadequacies or omissions in the specification of the one tend, quite intuitively, to induce overestimation of the importance of the other. However, secondarily, even if the *common-conditions* and *interdependence* mechanisms are modeled perfectly, the spatial-lag regressor(s) in this model will be endogenous (i.e. they will covary with the residuals), so estimates of ρ will suffer simultaneity biases. Moreover, as with the primary (relative) omitted-variable or misspecification biases mentioned first, these simultaneity biases in estimating the strength of *interdependence* induce biases in the opposite direction in estimating OE-CPE mechanism strength.

Equation (3.7) can be rewritten in matrix notation thus:

$$\mathbf{y} = \rho\mathbf{W}\mathbf{y} + \mathbf{X}\boldsymbol{\beta} + \varepsilon, \tag{3.8}$$

where $\mathbf{y}$ is an $NT \times 1$ vector of observations on the dependent variable stacked by unit (i.e. unit 1, time 1 to T, then unit 2, time 1 to T, etc. through unit N), and

W is an $NT \times NT$ block-diagonal spatial-weighting matrix (with elements w_{ij}). Thus, **Wy** is the spatial lag, given in scalar notation as the first term on the right-hand side of equation (3.2). The diagonal elements of the off-diagonal $T \times T$ blocks in **W**, which reflect the contemporaneous effect of the column unit on the row unit, are the w_{ij} that reflect the degree of connection from unit j to i – so, unlike a variance–covariance matrix, **W** need not be symmetric. ρ, the spatial autoregressive coefficient, reflects the impact of the outcomes in the other ($j \neq i$) spatial units, as weighted by w_{ij}, on the outcome in i. Thus, ρ gauges the overall strength of diffusion, whereas the w_{ij} describe the relative magnitudes of the diffusion paths between the sample units.

Generally, the set of w_{ij} is determined by theoretical and substantive argumentation as to which units will have greatest affect on outcomes in other units; ρ values are the coefficients to be estimated on these spatial lags. For example, operationalization of the tax-competition argument would be weights, w_{ij}, based on the trade or capital-flow shares of countries j in country i's total. The inner product of that vector of weights with the stacked dependent variable **y** then gives the weighted sum (or average) of **y** in the other countries j in that time-period as a right-hand-side variable in the regression. The matrix **Wy** just gives the entire set of these vector inner products – in this case, the trade- or capital-flow-weighted averages – for all countries i.[7] **X** is a matrix of NT observations on K exogenous regressors – in our case, η, ξ, and $\eta \cdot \xi$ – $\boldsymbol{\beta}$ is a $K \times 1$ vector of coefficients thereupon, and $\boldsymbol{\varepsilon}$ is an $NT \times 1$ vector of residuals, with the usual properties assumed.

In Franzese and Hays (2004, 2006), we demonstrate analytically, in the simplest possible case (one domestic factor, X, two countries, 1 and 2, and conditionally *i.i.d.* errors, ε) that OLS estimates of equation (3.7) (or the identical (3.8)) will suffer simultaneity bias and, obviously, that OLS estimates of equation (3.7) omitting the spatial lag will suffer omitted-variable bias, and we specify those biases insofar as possible.

This simple case highlights that OLS estimates of equation (3.7) will suffer simultaneity (endogeneity) bias:

$$Y_1 = \beta_1 X_1 + \rho_{12} Y_2 + \varepsilon_1 \tag{3.9}$$

$$Y_2 = \beta_2 X_2 + \rho_{21} Y_1 + \varepsilon_2. \tag{3.10}$$

The left-hand side of equation (3.9) is on the right-hand side of equation (3.10) and vice versa: Textbook endogeneity. In words: Country 2 affects country 1, but

country 1 also affects country 2. The resultant bias in OLS estimates of ρ can be shown (with a little further simplification) to equal:

$$\hat{\rho}_{12} = \rho_{12} + \frac{\rho_{21}\mathrm{Var}(\varepsilon_1)(1 - \rho_{21}\rho_{12})}{\beta_2^2 + \rho_{21}^2\mathrm{Var}(\varepsilon_1) + \mathrm{Var}(\varepsilon_2)}. \tag{3.11}$$

which, assuming $\rho_{12}\rho_{21} < 1$, implies that OLS estimates of diffusion from country *j* to *i* will have bias of the same sign as the diffusion from *i* to *j* (N.B. all terms except ρ_{21} in equation (3.6) are necessarily positive). This means that, if 'feedback' from *j* to *i* and *i* to *j* reinforce (both positive as in Figure 3.1, or both negative), then OLS estimates of interdependence will be inflated. If feedback is dampening (e.g. opposite slopes in Figure 3.1), which is probably less likely in most substantive contexts (but possible in Persson and Tabellini's model, as noted), OLS estimates will be attenuated. We can also show, moreover, that this bias in the estimated strength of interdependence, ρ, induces an attenuation bias in the estimate of β, the effect of X (i.e. domestic and/or exogenous-external factors):

$$\hat{\beta}_1 = \beta_1 - \frac{\beta_1\mathrm{Var}(\varepsilon_1)\ \rho_{21}^2}{\beta_2^2 + \rho_{21}^2\mathrm{Var}(\varepsilon_1) + \mathrm{Var}(\varepsilon_2)}. \tag{3.12}$$

Thus, typically, OLS estimates of C&IPE models will tend to overestimate the importance of interdependence – e.g. tax competition – and underestimate that of domestic, exogenous-external, and/or domestic-context-conditional exogenous-external mechanisms (i.e. OE-CPE arguments).

On the other hand, OLS estimates of OE-CPE models that ignore interdependence, i.e. that omit spatial lags, will suffer the converse omitted-variable biases, which we have (more easily, using the usual omitted-variable-bias formula) shown in the simplest case to equal:

$$\hat{\beta}_1 = \beta_1 + \frac{\rho_{12}\rho_{21}\beta_1}{1 - \rho_{12}\rho_{21}} \tag{3.13}$$

$$\hat{\beta}_2 = \beta_2 + \frac{\rho_{12}\rho_{21}\beta_2}{1 - \rho_{12}\rho_{21}}. \tag{3.14}$$

Again, if feedback is reinforcing (same-signed ρ_{12}, ρ_{21}) these are inflation biases and if feedback is dampening these are attenuation biases. Thus, in the positive-feedback case that we suspect is more common, OLS estimates of OE-CPE models that ignore *interdependence* will tend to overestimate the power of domestic, exogenous-external, and/or domestic-context-conditional exogenous-external

explanations. Finally, this conclusion holds as a matter of degree also: Insofar as *interdependence* is inadequately specified, absolutely and relatively to the alternative OE-CPE argument specification, the latter will tend to be overestimated and the former underestimated, and vice versa.

Our simulations suggested that these omitted-variable biases of excluding *interdependence* are of greater concern than the simultaneity biases of including them in OLS regressions, under a fairly wide range of plausible substantive conditions. Therefore, regarding the substantive application at hand here, researchers unambiguously do better to include the spatial lags needed to specify correctly the strategic interdependence implied by tax-competition arguments than to ignore/omit that implication. However, we also showed that simultaneity biases from including spatial lags in OLS regressions to reflect interdependence can be appreciable, that they tend toward overestimating the central quantity of interest here (ρ), and, worse still, that underestimation of the variance–covariance of its estimate (i.e. its standard error) also prevails.[8] Thus, on the one hand, hypothesis tests that fail to model the interdependence mechanism at all, i.e. OE-CPE models, will obviously fail to find such interdependence (e.g. tax competition) and, somewhat less obviously, tend to overestimate the importance of domestic and exogenous-external conditions; On the other hand, however, hypothesis tests based on OLS estimations of *correctly specified* models like equation (3.7) would be biased in favor of finding strong tax-competition effects, perhaps greatly so because the relevant *t*-statistics have inflated numerators and deflated denominators, and would tend to understate the importance of domestic and exogenous-external effects.

Fortunately, one can estimate models like equations (3.7) or (3.8) of interdependent processes, such as tax competition, by two-stage-least-squares instrumental variables (2SLS-IV) or by maximum likelihood (ML), to obtain consistent estimates of ρ and of $\boldsymbol{\beta}$. In fact, the former is not difficult to implement[9] because the spatial structure of the data itself suggests potential instruments. Valid instruments must satisfy that their (asymptotic) covariance with the endogenous regressor – here, the spatially lagged outcomes in the other countries – is nonzero, and preferably large, whereas their (asymptotic) covariance with the residual in that equation is zero. Stated more intuitively: Valid instruments must affect the variable for which they instrument, preferably greatly, but must *not* affect the dependent variable except insofar as they affect the variable being instrumented. In the tax-competition context, this means that valid instruments must predict the tax policies of competitor countries but not affect the tax policies of the domestic country except insofar as they affect those foreign countries' tax policies. Thus, all of the **X** variables in equation (3.8), i.e. the foreign countries'

own domestic, exogenous-external, and domestic-context-conditional-external factors,[10] are candidate instruments! One simply uses the spatial lags of **X**, **WX** (i.e. the same **W** already used to generate the spatial lag itself, **Wy**), as instruments for the spatial lag in the first stage of the 2SLS-IV estimation. Fortunately, too, our Monte Carlo experiments show that such 2SLS-IV estimates not only produce consistent estimates, but also essentially unbiased ones, even at relatively small sample sizes. Moreover, the accompanying 2SLS-IV standard-error estimates accurately reflected the true sampling variability of the 2SLS-IV coefficient estimates across all sample sizes and parameter conditions explored. This suggests spatial 2SLS-IV, unlike spatial OLS, will produce unbiased hypothesis tests.

Unfortunately, 2SLS-IV estimates are not typically very efficient and, indeed, are routinely outperformed in mean-squared-error terms by simple OLS estimates (and usually by the ML estimates also). That is, spatial 2SLS-IV suffers the typical IV problem of weak instruments. In other words, spatial 2SLS-IV estimates have larger standard errors than alternative estimators, often large enough to more than offset their unbiasedness, but, in their defense, as noted above, at least they honestly report these larger standard errors. Furthermore, as is virtually always true, perfectly exogenous instruments cannot be guaranteed. In the spatial 2SLS-IV context, the problem of *quasi-instruments* (Bartels, 1991) will arise in the presence of what we call *cross-spatial endogeneity*. That is, foreign countries' domestic and exogenous-external explanators will not be valid instruments for foreign countries' outcomes if the outcome in the domestic country correlates for some reason with the explanators in the foreign country. In our context, this would mean if tax policies in one country somehow affected other countries' domestic conditions. Canadian taxes affecting German election outcomes, for example, might seem implausible so, on this basis, the proposed spatial instruments may have a strong claim to exogeneity.[11] However, cross-spatial endogeneity can also arise without such direct 'diagonal causal arrows' from one country's outcomes to others' explanatory (domestic) factors because, intuitively, combinations of 'horizontal' and 'vertical' arrows can make 'diagonal' ones. That is, if the more usual sort of endogeneity problems exist, wherein **y** (tax policies) causes **X** (e.g. domestic industrial structure), and spatial correlation among the **X** variables exists also (e.g. industrial structure correlates across countries), then the 'diagonal' that violates spatial-instrument validity, covariance of $\mathbf{WX}_j$ with $\mathbf{y}_i$, emerges. In sum, therefore, we can believe the instrumentation assumptions necessary for consistency (and asymptotic efficiency[12]) of spatial 2SLS-IV estimates of the strength of interdependence if we believe (a) direct effects from $\mathbf{y}_i$ to $\mathbf{X}_j$ do not exist and (b) the **X** variables are either spatially uncorrelated or exogenous to **y**.[13]

Researchers interested in spatial interdependence, which necessarily includes those interested in tax competition, therefore face a troubling dilemma. They obviously must specify empirical models that reflect the dependence of one country's policies on those of their competitors; Interdependence, after all, is the core of their argument, and the testing for and gauging of it the core of their empirical estimations. In fact, though, even researchers uninterested in interdependence per se, and interested only in comparative- or open-economy-comparative-political-economy questions, must specify empirical models that reflect spatial interdependence (if it exists) to avoid potentially severe omitted-variable biases in their quantities of interest. Indeed, one way to phrase our primary conclusion from these econometric explorations would be to emphasize that accurate and powerful specification of the alternative is as critical to scholars solely interested in C&IPE from either the CPE or IPE angle as it is to those interested in C&IPE jointly. Any insufficiency in the specification of the one side will tend to bias our conclusions toward the other. Beyond this, however, i.e. even after we are fully satisfied (or as satisfied as we can be) with the domestic, exogenous-external, and interdependent aspects of our model specification, the researcher into substantive contexts like tax competition still faces a dilemma in choosing estimators. Spatial 2SLS-IV estimates seem to perform well in terms of coefficient unbiasedness and accuracy of reported standard errors and so should tend to produce unbiased hypothesis tests. However, these tests may be relatively weak (lack power) given that the estimators are inefficient; Moreover, the spatial 2SLS-IV estimates are sufficiently inefficient that one would prefer the simpler spatial OLS point estimates on mean-squared error grounds.

One reasonable approach to this dilemma would be to report point estimates of the strength of diffusion, ρ, and other model coefficients, $\boldsymbol{\beta}$, from the smaller mean-squared-error S-OLS or S-ML procedure, but to report the hypothesis tests with better unbiasedness properties from the 2SLS-IV procedure, being sure to acknowledge the latter's lack of power, which means to avoid drawing conclusions from failures to reject even more so than one always should, even with more powerful tests. However, this approach leaves ambiguous which standard errors to report. Standard errors from S-OLS tend to be 'inaccurately too small' and, as we also showed in Franzese and Hays (2004, 2006), PCSEs will not necessarily help with this particular problem. Standard errors from spatial 2SLS-IV, conversely, tend to be 'accurately too large' and refer to different point estimates besides. (S-ML standard errors have proven reasonably accurate under many conditions, but unfortunately quite wildly erratic in others, which is why we eschew them here.) At this point, the best we can offer is the advice to show readers both

and refer them to our Monte Carlo experiments to decide for themselves which or which combination of estimates they prefer, as none statistically dominates.

3.5 Spatial-lag empirical models of capital-tax competition

Although all theoretical models of and arguments regarding tax competition clearly, indeed inherently, imply the spatial interdependence of capital taxes, few scholars have empirically modeled such interdependence directly. Two recent exceptions (Hays, 2003; Basinger and Hallerberg, 2004), however, do estimate spatial-lag models of international capital-tax competition, using S-OLS. In the next section, we discuss the empirical work in these two papers and then conduct a reanalysis of the regression models in Hays (2003). Our empirical results support the conclusion of strong international interdependence in capital-tax policy.

Hays (2003) argued that the effect of globalization – specifically, increased international capital mobility – on a country's capital tax rate depends on its capital endowment and political institutions. Thus, his theoretical argument is of the OE-CPE variety. An exogenous increase in international capital mobility affects the capital tax rate in two ways. First, it shifts the revenue-maximizing tax rate downward. Second, by making the supply of capital more elastic, it increases the marginal gain from increasing (decreasing) the capital tax rate when it is below (above) the revenue-maximizing level. How much globalization reduces the revenue-maximizing tax rate depends on a country's capital endowment: The drop is large for capital-rich countries and relatively small for capital-poor ones. The impact of increasing the elasticity of the supply of capital on tax rates, conversely, is a function of a country's political institutions. In brief, the capital-supply elasticity determines the marginal revenue gain from changing tax rates while political institutions determine the marginal cost of changing tax rates. Hays's theoretical argument explains why increased international capital mobility will have the greatest negative impact on capital-tax rates in relatively closed and capital-rich countries with majoritarian political institutions (e.g. the UK).

To test this hypothesis, Hays estimated a spatial-lag model with a temporal lag and country-fixed effects. The Mendoza et al. (1997) capital-tax rates are the dependent variable; The key independent variables are the degree of capital mobility – measured by Quinn's (1997) indices of capital and financial openness – and capital mobility interacted with a measure of each country's capital endowment

and its consensus-democracy score (Lijphart, 1999).[14] For each country, Hays (2003) used the average tax rate, i.e. the average of the dependent variable, **y**, in the $N - 1$ other countries as the spatial lag. In other words, all the off-diagonal elements of the spatial weighting matrix from equation (3.8) are set to $1/(N - 1)$. For Hays's original purposes, this spatial lag controls for the possibility that the observed changes in capital taxation are being driven by tax competition between countries.[15] Hays estimated the model using OLS and reported panel-corrected standard errors (PCSEs).

For their part, Basinger and Hallerberg (2004) estimated spatial-lag models to test the following hypotheses derived from their theoretical model of tax competition: (1) Countries will undergo tax reform more frequently if the political costs of such reforms are low and/or the decisiveness of reforms in determining the patterns of investment flows is high; (2) Countries will engage in tax reform when the political costs of reform in competitor countries is low; (3) The domestic political costs of reform and the decisiveness of reform will determine the sensitivity of countries' tax policies to tax changes in their competitors. Basinger and Hallerberg (2004) included both spatially weighted **X** variables and spatially weighted **Y** variables (i.e. spatial lags) on the right-hand side of their regression models. Hypothesis 1 is operationalized with a set of domestic **X** variables; They tested Hypothesis 2 using a set of spatially weighted **X** variables and Hypothesis 3 with the spatial lags interacted with domestic **X** variables.

The dependent variable in their empirical analysis is the change in the capital-tax rate. In addition to the Mendoza et al. (1997) capital-tax rates, the same variable Hays (2003) used, Basinger and Hallerberg (2004) considered also the top marginal capital-tax rates (of both central government and overall). They identified two kinds of domestic political costs as independent variables: Transaction and constituency costs. *Ideological distances* between veto players were used to measure transaction costs. The greater the ideological distance between political actors that can block policy change, the harder is altering the status quo (in this case, adopting capital-tax reform). *Partisanship* was used to measure constituency costs; The constituency costs associated with capital-tax reform will be higher when left governments are in power. A third independent variable of interest, the degree of capital mobility, was measured using capital controls on outflows (based on Quinn's data). The degree of capital mobility determines the decisiveness of capital taxes in determining the location of international investments.

Basinger and Hallerberg (2004) used four different spatial-weighting matrices: A symmetric $1/(N - 1)$ weighting matrix, which makes the spatial lag for each unit equal to the simple average of the **Y** values in the other units (as in Hays),

and three weighted averages using, respectively, GDP, FDI, and Fixed Capital Formation (FCF) as weights. The last three spatial-weighting matrices have cell entries that differ across columns, but the rows are identical. For example, for every country (row) in the sample, the USA (column) – because of its large GDP, capital stock, and flows of FDI – is weighted more heavily than Finland (another column), but the effect of American tax rates on other tax rates is the same for all countries (in every row). American tax rates (column) have the same effect on Canada (row) as they do on Austria (another row), for example. These spatial weights are time varying (because the GDP, FDI, and FCF of each country changes over time). Like Hays, Basinger and Hallerberg (2004) included country-fixed effects in their models, but, unlike Hays, they did not lag the dependent variable directly. They did include the lagged level of the tax rate, though, which makes their model with changes as the dependent variable essentially the same as a partial-adjustment (lagged-dependent-variable) model in levels like the one Hays estimates. Finally, Basinger and Hallerberg (2004) also estimated their models by OLS with panel-corrected standard errors.

Both Hays (2003) and Basinger and Hallerberg (2004) found the coefficient on the spatial lag to be positive and statistically significant – i.e. both found strong evidence of tax competition. The problem with both analyses, however, is that neither accounts for the endogeneity of the spatial lag, which renders biased and inconsistent the S-OLS estimator used. As we showed in Franzese and Hays (2004, 2006), the simultaneity bias in these circumstances would be toward exaggeration of the strength of interdependence and would also entail an induced downward bias in the estimated effects of *common conditions*. Furthermore, both may have underspecified the *common-conditions* sorts of arguments they include as well, which, again as we showed in Franzese and Hays (2004, 2006), would tend further to depress those estimated effects and inflate the estimated strength of interdependence. We therefore conduct now a reanalysis of Hays's (2003, p. 99)[16] regressions using a new spatial-weight matrix and two consistent estimators – spatial two-stage least squares and spatial maximum likelihood (Tables 3.1 and 3.2). We also re-estimate the regressions, including a set of period dummies to control better for common shocks (Table 3.3).[17] The results show that Hays may have overestimated the coefficient on the spatial lag with consequences for some of the other estimates. In particular, the original results for the mediating effect of the capital endowment on capital-account openness are not very robust across alternative estimators. However, the consensus democracy results are robust and tend to be even stronger (i.e. larger coefficients and higher levels of statistical significance) when the consistent estimators are used.

Table 3.1 Capital tax rates and international capital mobility (capital-account openness)

Independent variables	Capital-account openness	Capital-account openness	Capital-account openness	Capital-account openness	Capital-account openness	Capital-account openness
Capital mobility	1.918**	2.223**	2.159**	1.620*	1.695*	1.729*
	(0.919)	(0.930)	(1.045)	(0.859)	(0.996)	(1.013)
Capital mobility interacted with:						
Capital	−0.070*	−0.069*	−0.069**	−0.033	−0.0425	−0.048
endowment	(0.040)	(0.040)	(0.033)	(0.039)	(0.030)	(0.040)
Consensus	0.484	0.746*	0.691	1.245***	1.053**	1.121**
democracy	(0.431)	(0.434)	(0.472)	(0.428)	(0.485)	(0.534)
Corporatism	−1.186	−2.229	−2.008	−3.047**	−2.578*	−2.453
	(1.339)	(1.359)	(1.399)	(1.318)	(1.357)	(1.641)
Left government	0.370*	0.286	0.304	0.304	0.321	0.331
	(0.196)	(0.195)	(0.209)	(0.186)	(0.196)	(0.215)
Population	−1.7ge-07	−9.77e-06**	−7.74e-06*	5.79e-07	3.88e-07	0.001
	(3.49e-06)	(3.98e-06)	(4.03e-06)	(3.30e-06)	(3.60e-06)	(0.004)
European Union	−0.204	−0.465***	−0.410**	−0.520***	−0.440**	−0.442***
	(0.161)	(0.170)	(0.185)	(0.161)	(0.176)	(0.168)
Temporal lag	0.834***	0.754***	0.771***	0.686***	0.723***	0.706***
	(0.034)	(0.039)	(0.028)	(0.043)	(0.031)	(0.038)
Spatial lag		0.280***	0.221***	0.0316***	0.237***	0.267***
		(0.066)	(0.048)	(0.049)	(0.035)	(0.044)
Obs.	465	465	465	465	465	465
Estimation	Nonspatial OLS	Spatial OLS	Spatial 2SLS	Spatial OLS	Spatial 2SLS	Spatial ML
Diffusion		Uniform	Uniform	Nonuniform	Nonuniform	Nonuniform

Notes: The regressions were estimated with fixed country effects (coefficients for country dummies not shown).
For the OLS estimates, panel-corrected standard errors are given in parentheses.
For the 2SLS estimates, robust standard errors clustered by year are given in parentheses.
For the ML estimates, robust standard errors are given in parentheses.
*** Significant at 1%; ** Significant at 5%; * Significant at 10%.

Table 3.2 Capital tax rates and international capital mobility (financial openness)

Independent variables	Financial openness	Financial openness	Financial openness	Financial openness	Financial openness	Financial openness
Capital mobility	0.858***	0.988***	0.958**	0.725**	0.758**	0.741**
	(0.338)	(0.342)	(0.359)	(0.313)	(0.345)	(0.322)
Capital mobility interacted with:						
Capital endowment	−0.029*	−0.034**	−0.033**	−0.024*	−0.025**	−0.028*
	(0.015)	(0.016)	(0.013)	(0.014)	(0.011)	(0.014)
Consensus democracy	0.209	0.306*	0.283*	0.422***	0.369**	0.369**
	(0.154)	(0.157)	(0.165)	(0.151)	(0.161)	(0.168)
Corporatism	−0.534	−0.817*	−0.751	−0.888**	−0.799	−0.656
	(0.471)	(0.490)	(0.603)	(0.451)	(0.567)	(0.612)
Left government	0.099*	0.085	0.088	0.089*	0.0916	0.095
	(0.054)	(0.054)	(0.057)	(0.051)	(0.055)	(0.059)
Population	2.45e-07	−2.10e-06*	−1.55e-06	2.13e-07	2.21e-07	0.000
	(1.04e-06)	(1.23e-06)	(1.11e-06)	(9.83e-07)	(9.79e-07)	(0.001)
European Union	−0.075*	−0.148***	−0.131**	−0.156***	−0.136***	−0.131***
	(0.046)	(0.050)	(0.050)	(0.045)	(0.045)	(0.044)
Temporal lag	0.825***	0.751***	0.768***	0.682***	0.718***	0.702***
	(0.036)	(0.040)	(0.030)	(0.044)	(0.031)	(0.038)
Spatial lag		0.261***	0.200***	0.309***	0.231***	0.261***
		(0.066)	(0.053)	(0.047)	(0.036)	(0.043)
Obs.	465	465	465	465	465	465
Estimation	Nonspatial OLS	Spatial OLS	Spatial 2SLS	Spatial OLS	Spatial 2SLS	Spatial ML
Diffusion		Uniform	Uniform	Nonuniform	Nonuniform	Nonuniform

Notes: The regressions were estimated with fixed country effects (coefficients for country dummies not shown).
For the OLS estimates, panel-corrected standard errors are given in parentheses.
For the 2SLS estimates, robust standard errors clustered by year are given in parentheses.
For the ML estimates, robust standard errors are given in parentheses.
*** Significant at 1%; ** Significant at 5%; * Significant at 10%.

Table 3.3 Capital tax rates and international capital mobility (fixed period effects)

Independent variables	Capital-account openness	Capital-account openness	Capital-account openness	Financial openness	Financial openness	Financial openness
Capital mobility	2.162**	1.993*	2.397**	0.918***	0.843**	0.974***
	(0.909)	(1.0115)	(0.941)	(0.327)	(0.345)	(0.309)
Capital mobility interacted with:						
Capital endowment	−0.048	−0.039	−0.067*	−0.028	−0.024*	−0.035**
	(0.045)	(0.032)	(0.038)	(0.017)	(0.012)	(0.015)
Consensus democracy	1.156**	1.287**	1.096**	0.417**	0.447***	0.380**
	(0.506)	(0.507)	(0.514)	(0.168)	(0.159)	(0.161)
Corporatism	−3.373**	−3.464**	−2.935*	−1.070**	−1.061*	−0.853
	(1.487)	(1.318)	(1.548)	(0.515)	(0.545)	(0.585)
Left government	0.186	0.203	0.199	0.059	0.06171	0.063
	(0.188)	(0.203)	(0.203)	(0.051)	(0.056)	(0.055)
Population	−6.03e-06	−2.40e-06	−0.008*	−1.04e-06	−2.37e-07	−0.002
	(4.25e-06)	(5.67e-06)	(0.004)	(1.18e-06)	(1.58e-06)	(0.001)
European Union	−0.649***	−0.627***	−0.654***	−0.193***	−0.186***	−0.191***
	(0.192)	(0.195)	(0.187)	(0.058)	(0.056)	(0.053)
Temporal lag	0.723***	0.713***	0.724***	0.719***	0.708***	0.720***
	(0.044)	(0.033)	(0.038)	(0.045)	(0.033)	(0.038)
Spatial lag	0.157**	0.243***	0.118**	0.166***	0.247***	0.128**
	(0.068)	(0.076)	(0.059)	(0.060)	(0.070)	(0.057)
Obs.	465	465	465	465	465	465
Estimation	Spatial OLS	Spatial 2SLS	Spatial ML	Spatial OLS	Spatial 2SLS	Spatial ML
Diffusion	Nonuniform	Nonuniform	Nonuniform	Nonuniform	Nonuniform	Nonuniform

Notes: The regressions were estimated with fixed country and period effects (coefficients for country and period dummies not shown).
For the OLS estimates, panel-corrected standard errors are given in parentheses.
For the 2SLS estimates, robust standard errors clustered by year are given in parentheses.
For the ML estimates, robust standard errors are given in parentheses.
*** Significant at 1%; ** Significant at 5%; * Significant at 10%.

Hays (2003) used two policy measures of international capital mobility from Quinn: Capital-account openness and financial openness. The first variable is specific to restrictions on capital-account transactions. The second, a broad measure of financial openness, reflects restrictions on either capital- or current-account transactions. Both of these measures vary across countries but have a common time-trend towards liberalization. Therefore, thinking of capital mobility as representing a common external variable makes sense. Table 3.1 presents the results of our reanalysis for the capital-account openness models. The original estimates are reported in the second column, labeled 'Spatial OLS' and 'Uniform diffusion'. By uniform diffusion we mean that Hays used a spatial-weighting matrix with off-diagonal elements that all take a value of $1/(N-1)$. In our reanalysis, we also include a nonuniform weighting matrix based on observed cross-national correlations in capital-tax rates. For each country's row in the spatial-weighting matrix we enter ones for the countries with which its capital-tax rates have a statistically significant positive correlation. We then row-standardize the resulting spatial-weighting matrix.[18] The weighting matrix is nonuniform in the sense that, unlike in the uniform case, Country A's importance in determining Country B's capital-tax rate may not be the same as Country B's importance in determining Country A's tax rate.[19]

We report nonspatial OLS estimates in the first column of Table 3.1 to demonstrate the sizable omitted-variable bias (seen relative to the other columns) when the spatial lag is omitted. Notably, the nonspatial OLS estimate for the consensus-democracy interaction term is about 35% smaller than the original S-OLS estimate and statistically insignificant. Then, two things worry us about Hays's original estimates in the second column. First, he uses S-OLS, which is likely to inflate the estimate of the crucial ρ coefficient because the spatial lag is endogenous. This simultaneity bias induces bias in the other coefficient estimates as well (Franzese and Hays, 2004, 2006). Second, Hays used a uniform spatial-weighting matrix. Each country's capital-tax rate in the sample is assumed equally important in determining every other country's tax rate. This convenience assumption gives a simple unweighted average of the capital-tax rates in the other countries as the spatial lag. If this assumption is wrong, which it almost certainly is in this case, the spatial lag contains measurement error, which may cause attenuation bias in the spatial-lag coefficient estimate (and induced biases in the other coefficient estimates).[20] Note that the feared simultaneity and measurement-error biases work in opposite directions here.

The estimates in the third and fourth columns are consistent with our expectations. First, when we estimate by S-2SLS, the estimated coefficient on the spatial

lag drops from 0.280 to 0.221 (a 21% reduction) and, when we use the nonuniform spatial-weighting matrix, the estimate increases to 0.316 (+13%). Columns 5 (S-2SLS) and 6 (S-ML) make both 'corrections': One of the two consistent estimators and the nonuniform spatial-weighting matrix. The results, which are very similar across the two estimators, suggest that, on balance, Hays overestimated the coefficient on the spatial lag (i.e. the simultaneity bias seemed to have dominated) and so underestimated the coefficients on the capital-mobility variable and the capital-mobility-times-consensus-democracy interaction variable (induced biases). In more general terms, due to the endogeneity of the spatial lag, Hays (2003) seems to have overestimated the importance of international factors (tax competition) at the expense of domestic (consensus democracy) and common external factors (capital mobility), which is just what our simulations (Franzese and Hays, 2004, 2006) would lead us to expect. Our reanalysis of Hays's financial-openness model in Table 3.2 tells a similar story.

First, nonspatial OLS produces serious omitted variable bias (column 1, Table 3.2). Second, Hays (2003) probably overestimated the coefficient on the spatial lag and underestimated the coefficients on the capital-mobility and consensus-democracy interaction variables (columns 5 and 6 vs. column 2). In Table 3.3, finally, we include period dummies in the models to control more thoroughly for common shocks. Again, we expect this will cause S-OLS to underestimate the coefficient on the spatial lag for the same reason adding unit dummies causes OLS to underestimate the coefficient on temporal lags: Hurwicz or Nickell bias.[21] We expect to find an analogous spatial-Hurwicz bias in the spatial-lag estimates here (Hurwicz, 1950). Again, the results from our reanalysis are largely consistent with this expectation. The estimated coefficient on the spatial lag in the capital-account-openness model drops by 50% from 0.316 to 0.157 (column 4, Table 3.1 vs. column 1, Table 3.3) with the addition of the period dummies. In the financial-openness model, the ρ estimate is 46% smaller with period dummies (column 4, Table 3.2 vs. column 4, Table 3.3).[22]

3.6 Conclusion

Theoretically and substantively, we expect international interdependence in capital-tax policy. Empirically, Hays (2003) and Basinger and Hallerberg (2004) demonstrated such interdependence using spatial-lag models that specify one country's capital tax rate to depend on the capital tax rates in other countries. However, estimating spatial-lag models is, to be brief, a tricky business. In this

paper, we highlighted two problems caused by the endogeneity of the spatial lag and measurement error. Our reanalysis of Hays's (2003) regressions suggests that both these problems are present, although his key substantive conclusions remain qualitatively unchanged. International capital-tax competition is very real and rather stiff in general, but it does not imply some unmitigated *race to the bottom*. The stiffness of the competition depends on what competitors are doing and that depends on the competitors' domestic political–economic and exogenous global contexts. The response to the competition that does emerge depends on the home countries' domestic political–economic contexts and exogenous global contexts.

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Notes

1. Hays (2003), however, makes a small-country assumption in his theoretical model to simplify the formal model by eliminating the role of strategic interdependence.
2. Unskilled labor is usually relatively mobile within (national) jurisdictions but highly immobile across jurisdictions, especially those borders delineating strongly differentiated ethnic, linguistic, religious, and cultural societies. Some types of skilled labor are highly specialized into specific productive activities, which may limit intra- and inter-jurisdictional mobility; Other types, some *human capitalists* for example, may be relatively mobile across jurisdictions.
3. Franzese (2003) offers a more complete review of Swank (2002).
4. Government consumption is not only fixed but also entirely wasted, i.e. it enters no one's utility function.
5. The issues grouped in the econometric literature under the heading *spatial* interdependence need not actually have geometric or geographic *space* as the metric of dependence, as the tax-competition venue illustrates nicely. Competitors or closer competitors for capital need not

share borders or be geographically closer but, rather, are closer by some economic considerations (which may include geographic proximity, certainly).

6. Equation (3.6) models these exogenous-external conditions as common to all units (N.B. no subscript *i*) but, generally, they will at least correlate across units.
7. Another common spatial-lag specification, frequently used to specify contiguity, leader-emulation, or cultural-connection mechanisms of interdependence, for example, is to consider outcomes from unit or set of units *j* to diffuse to the outcome in *i* but not the outcomes from other units. For example, only outcomes from countries with similar religious or political heritage diffuse. This implies the weights are 1 (for sums; $1/(N-1)$ for averages) or 0, so diffusion either occurs from some *j* to some *i* or it does not, but otherwise the math is the same.
8. Furthermore, PCSEs did not seem to help much in this last regard.
9. The latter is not so much difficult as computationally intensive. These two methods are the ones we explored and most commonly discussed, but are not exhaustive of those potentially capable of returning 'good' estimates of β and ρ.
10. The exogenous-external factors may seem not to satisfy the intuitive statement of valid instruments because they enter both domestic- and foreign-country tax policies. However, they enter both exogenously so, although they do not provide much leverage or power to the instrumentation – they do so only insofar as they are domestic-context conditioned and this context conditioning correlates (exogenously) across countries – they are nonetheless valid.
11. On the other hand, Persson and Tabellini (2000) discussed just such 'strategic delegation' as one implication of their model. Voters in one country have incentives to support a citizen-candidate of greater or lesser capital-labor endowment than themselves precisely because they internalize the effect on their own capital-tax rates of foreign elections.
12. *Asymptotic efficiency* should not at all be confused with *efficiency*. The former is an extremely weak property, stating only that as sample sizes *approach infinity* estimates *become* the most efficient ones and nothing at all necessarily about the relative or absolute efficiency of the estimates along the path they follow as sample sizes approach infinity. Furthermore, if one had infinite samples, efficiency would be virtually irrelevant.
13. The latter of the two parts of (b) is of course the usual regressor-exogeneity assumption necessary to the unbiasedness and consistency of all LS estimators. However, violation of it alone produces biased and inconsistent estimates of $\boldsymbol{\beta}$, not of ρ (except insofar as bias in the former induces bias in the latter, which, by usual induced-bias intuition, only occurs in some dampened proportion to the degree to which a typical single country's domestic **X** correlates with the foreign **y** in its spatial lag, which is not usually very much).
14. The capital-endowment data are from the Penn World Tables. Hays used the capital stock per worker in 1965 as a measure of each country's initial capital endowment.
15. While Hays's regression models allowed for tax competition, his theoretical model made a small-country assumption and so did not, because the global after-tax return to capital is exogenous to small countries. Tax competition is not inconsistent with his theory, but Hays's original focus is on strategic interaction (among producer groups) within countries rather than on tax competition between countries.
16. Table 3.2 reports the original estimates as well.
17. Neither Hays nor Basinger and Hallerberg reported results that included period dummies. (Period dummies are a simple method to control for common shocks.) This is problematic in

that if common shock variables are underspecified, estimated coefficients on spatially weighted variables are likely to be inflated (Franzese and Hays, 2004, 2006). However, Basinger and Hallerberg argued that period dummies create a multicolinearity problem for their models. Distinguishing common shocks from uniform, $1/(N-1)$, diffusion is especially difficult, and Franzese and Hays (2003) argued that such period dummies may also create a spatial-Hurwicz/Nickell bias in the estimates for spatial-lag coefficients. Whether the benefits of period dummies outweigh the costs is ambiguous and probably should be assessed on a case-by-case basis.

18. Row standardization replaces the ones in each country's row in the weighting matrix with $1/N$, where N is the number of countries with which its tax rate is correlated. In other words, if a country's capital tax rate is positively correlated with five other countries, the appropriate cells in the weighting matrix take a value of 0.2. This procedure normalizes the sums across rows of cell entries to one in each row.
19. For example, if Country A's tax rate is correlated with five other countries and Country B's tax rate is only correlated with Country A, the importance of Country A's tax rate (i.e. its weight in the spatial-weighting matrix) in determining Country B's tax rate will be greater than the reverse.
20. We see no strong reason to think this measurement error would be systematic.
21. For a discussion of this bias, see Beck and Katz (2004) on estimating dynamic models with TSCS data.
22. Interestingly, when period dummies are included in the models, the two consistent estimators (S-2SLS and S-ML) give very different estimates, particularly of the spatial-lag coefficient. In both the capital-account and financial-openness models, the S-2SLS estimates are approximately two times larger than the S-ML estimates. We suspect this problem results from an eigenvalue-approximation simplification of the likelihood function employed in Stata's spatial-regression package, which approximation we suspect performs poorly in the presence of high colinearity between the spatial lag and the other regressors. The correlation between period dummies and a spatial lag reflecting a uniform interdependence process is high (and grows with N, the number of units, reaching perfect colinearity at $N = \infty$).

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