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ABSTRACT: Decentralized fiscal decision making is more likely to be optimal if regional tax bases are non-rival, in the sense that one region's gain is no other relevant region's loss. We develop a method for estimating the rivalness of tax bases using the underlying structures of the conditional logit, Poisson and nested logit models. We use this method to estimate the effect of state-level capital taxation on U.S. inward foreign direct investment. While the results are rather noisy, the assumption of perfect non-rivalenss can in some cases be rejected, but the assumption of perfect rivalness cannot. Competition over FDI across U.S. states may well be a zero-sum game.

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1 Introduction

National and regional governments everywhere compete over mobile capital by devoting considerable resources to investment promotion. Measures ranging from advertising campaigns and information dissemination all the way to subsidies and tax breaks are designed to attract new firms and investment.

Such policies may well be efficient from the viewpoint of individual governments if new firms generate positive local externalities. What can be efficient for individual governments, however, could be inefficient for the aggregate (national or world) economy. If governments compete over mobile productive resources which exist in a fixed overall amount, that competition adds nothing to aggregate output. Governments then engage in a zero-sum or even negative-sum game. Conversely, that same competition will represent a positive-sum game if it increases aggregate output, either by stimulating economic activity that would otherwise not exist or by attracting productive resources from outside the territory considered.

In this paper, we point out a new way of discriminating empirically among competing models of investment location, exploiting the difference between conditional logit and Poisson estimation. We show how panel data can help us identify the degree of rivalness of local investment promotion policies through a parameter in a nested-logit model. We take this methodology to data for inward foreign direct investment (FDI) in the United States, using state-level statistics from the Bureau of Economic Analysis for 1977 to 2006 and exploiting policy variation measured through the user cost of capital. Our results suggests that state-level competition for FDI is largely zero-sum: while tax incentives have a significant influence on the distribution of investment across states, the total amount of investment is not significantly affected by state corporate tax policies.

The empirical literature on FDI location has so far largely overlooked this simple but essential distinction. The emphasis has predominantly been on quantifying the importance of manifold determinants of investment location - an important and challenging identification task in itself. The conventional estimation approach has been to rely on McFadden's (1974) conditional logit model, which offers a formally rigorous way to derive an estimable empirical model from the objective function of a representative location-seeking firm. A similarly popular empirical approach has been to use Poisson count estimation. It has been demonstrated by Guimaraes, Figueiredo and Woodward (2003) that, with purely location-specific locational determinants or with determinants that are specific to locations and to groups of firms, the two estimators return identical parameter estimates. In that sense, the two estimators are equivalent.

In earlier work (Schmidheiny and Brülhart, 2011), we have shown that the identical co-

efficient estimates resulting from the two estimation strategies in fact have fundamentally different economic implications. The implicit premise of the conditional logit model is that the aggregate amount of investment is fixed and that intergovernmental competition affects only the distribution of this investment across locations. In the Poisson model, however, the aggregate amount of investment is a function of locational determinants, such that an additional unit of capital attracted to one jurisdiction has no impact on investment in the remaining jurisdictions and thus raises the aggregate stock of capital by one unit. We showed how intermediate cases between these two extremes can be represented by a nested logit model featuring a generic "outside option". Here, we use the fact that the nested-logit elasticities are linear combinations of the two polar cases described by the conditional logit and Poisson models. Specifically, we estimate a "rivalness parameter" that fully describes the extent to which competition for investment deviates from the Poisson-benchmark of purely non-rival policies.

The paper is structured as follows. Section 2 provides a summary of existing research. In Section 3, we develop a novel empirical approach for estimating the interregional rivalness of economic resources. This approach is applied to data on inward FDI across U.S. states in Section 4. Section 5 concludes.

2 Literature review

The conditional logit model has first been applied to the estimation of the determinants of firm-level investment location choices by Carlton (1983), and the Poisson count model was first used in this context by Papke (1991).[1] Guimaraes *et al.* (2003) then showed that the two approaches yield identical estimates for models that do not feature firm-specific regressors. While their equivalence result is correct and useful in terms of estimation, we point out in Schmidheiny and Brülhart (2011) that the two models imply different economic interpretations.

The Guimaraes *et al.* (2003) equivalence result has become a popular motivation for using Poisson estimation of equations that are derived from conditional logit models. The original area of application, firms' location choices, remains central: Arzaghi and Henderson (2008) have used the Poisson estimator in a study of the location of advertising agencies in Manhattan; Davis and Henderson (2008) used it to identify the determinants of headquarter location across US counties; and Duranton, Gobillon and Overman (2011) used it to estimate

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[1]Prominent subsequent applications of the conditional logit model include Bartik (1985), Head, Ries and Swenson (1995, 1999), Guimaraes, Figueiredo and Woodward (2000), Figueiredo, Guimaraes and Woodward (2002), Devereux, Griffith and Simpson (2007), and Strauss-Kahn and Vives (2009). Prominent subsequent applications of the Poisson model include Becker and Henderson (2000), List (2001), Guimaraes, Figueiredo and Woodward (2004), and Holl (2004).

the locational determinants of firm entry in England. We have invoked the equivalence result in a study of the interplay of industry-level differences in agglomeration intensities and regional differences in tax rates as determinants of firm births in Switzerland (Brülhart, Jametti and Schmidheiny, 2011). Jofre-Monseny and Solé-Ollé (2010) provide a related analysis, based on data for Catalonia and also using the equivalence of the Poisson with the conditional logit. The equivalence of conditional logit and Poisson estimation is proving useful also in other areas of investigation. For instance, Coeurdacier, De Santis and Aviat (2009) have taken it as the basis for Poisson estimation of a model of cross-border mergers and acquisitions.[2]

Empirical research on competition over mobile capital has mainly focused on the elasticity of firm location (or employment, output or value added) in a particular region with respect to that region's own policy, with corporate taxes being the policy instrument that has been afforded greatest attention. This literature generally confirms that, other things equal, mobile firms seek out low-tax locations.[3]

The aggregate implications of uncoordinated policies aimed at attracting mobile investment, however, have remained comparatively underresearched. To the best of our knowledge, all existing empirical studies of this issue based on competition among US states suggest that such competition is essentially zero-sum. Head, Ries and Swenson (1999), based on a model of location choices by Japanese subsidiaries in the United States, concluded that the provision of foreign trade zones served to reallocate Japanese plants across states but did not alter the total number of Japanese investments in the US. Their simulations were based on a conditional logit model, which in fact already implies the zero-sum prediction. Goolsbee and Maydew (2000) explored how revisions in profit apportionment rules by US state governments towards formulae that do not penalize employment creation have affected state-level and aggregate employment growth. They found that such reforms indeed boosted own-state employment, but that they reduced aggregate out-of-state employment by almost exactly the same amount. Chirinko and Wilson (2008) and Wilson (2009) have analyzed the own-state and neighboring out-of-state effects of US state-level R&D tax credits, concluding that the two effects almost exactly offset each other.

3 Estimating the rivalness of tax bases

3.1 Conditional logit, Poisson, and nested logit

The three standard location choice models – conditional logit, nested logit and Poisson – imply starkly different predictions. Take a corporate tax cut in a particular region. Provided that

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[2]Following Silva and Tenreyro (2006), the Poisson approach has also become popular for the estimation of gravity models of international trade (e.g. Magee, 2008) and investment (e.g. Head and Ries, 2007).

[3]For a survey of this literature, see Hines (1999).

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this is perceived by investors as making that region more attractive, all three models predict that the region itself will see an increase in its capital base. The magnitude of the implied increase, however, differs: it is largest if the world is properly represented by the Poisson model, smallest if the world conforms with the conditional logit, and somewhere in-between if the world is nested logit. In a Poisson world, the tax cut will have no impact on investment elsewhere. It will, however, pull investment away from other regions in the conditional logit and the nested logit cases. As the total amount of investment is fixed in the conditional logit, the investment pulled away from the other regions exactly offsets the increase in investment in the tax-cutting region itself. The nested logit again represents an intermediate case, with some of the attracted investment being shifted from elsewhere within the data set, implying that regional corporate tax bases are "rival"; and some investment appearing from outside that set, implying a "non-rival" component of the tax base (see Figure 1 for an illustration).

The linear connection of the conditional logit and Poisson models through the nested logit can be quantified in a simple parameter, contained between zero and one, which measures the rivalness of the tax base (Schmidheiny and Brülhart, 2011). If the economy is purely zero-sum, such that one region's gain is some other region's equivalent loss, then the world corresponds to the conditional logit assumptions and the rivalness parameter is equal to one. Conversely, if the economy is purely positive-sum, such that one region's gain is no other region's loss, then the world corresponds to the Poisson assumptions and the rivalness parameter is zero. All intermediate cases are possible as well.

The rivalness parameter is eminently policy relevant and offers a rigorous link to the theory. Unfortunately, however, it cannot be estimated in cross-section data. After all, the Guimaraes *et al.* (2003) equivalence result implies that the models are observationally equivalent if estimated at a given point in time. In the presence of panel data, however, where tax burdens and tax bases are recorded across regions for more than one point in time, the rivalness parameter can in principle be identified. In a pure zero-sum world (i.e. where the rivalness parameter takes its maximum value of one), a change in tax rates in some regions will leave the aggregate size of the tax base across all relevant regions unchanged. This aggregate tax base, however, will grow if the world is positive-sum and some regions cut their tax rates. Hence, the degree of rivalness across regions can be inferred from changes in the aggregate tax base relative to a weighted average of the changes in tax burdens across regions. Below, we derive how the correct weights for this average can be calculated from the nested logit model.

For ease of exposition, we consider location choices of equally sized single-location firms, and we begin by abstracting from the time dimension. For "firms", one might equivalently read "investment projects" or "units of FDI". Let us denote firms with $f = 1, ..., N$, and regions with $j = 1, ..., J$. The random variable n_j represents the count of firms in region

j, whereas N_j denotes the number of firms actually observed in region j. Analogously, the random variable n represents the total number of firms, whereas N denotes the observed total number of firms.

We consider two scenarios. In Case A, determinants of locational attractiveness are purely region specific, such that they affect all firms symmetrically. Under Case B, we relax this assumption, and allow locational attractiveness to be region-industry specific.

3.2 Case A: industry-invariant locational determinants

Suppose that firm f's profit in region j is determined by the linear model $\pi_{fj} = x_j'\beta + \varepsilon_{fj}$, where the K observable characteristics of each region are given by the vector x_j, and β is a vector of coefficients. The parameters β can be estimated by maximum likelihood, using conditional logit, Poisson or nested logit assumptions. We now present each model in turn.

The *conditional logit* model is defined by the assumption that the random term ε_{fj} is independent across f and j, and follows an extreme-value type 1 distribution. With these assumptions, the probability that a given firm f chooses region j rather than any other region is given by

$$P_j = \frac{e^{x_j'\beta}}{\sum_{i=1}^{J} e^{x_i'\beta}}, \tag{1}$$

where $\sum_j P_{j|f} = 1$ for all f. Since locational characteristics x_j are assumed here to affect all firms symmetrically, this probability also represents the share of firms that will choose region j.

The conditional logit model implicitly assumes that the total number of firms n does not depend on the locational characteristics x_j. The expected number of firms in region j, is therefore given by $E(n_j) = nP_j$; and the expected total number of firms is equal to the observed total, N, irrespective of regressors and parameters, $E(n) = \sum_{j=1}^{J} E(n_j) = n = N$. This shows the "zero sum" aspect of the conditional logit model, which implies allocating an exogenously fixed number of firms over a set of regions.

The *Poisson* estimator is based on the assumption that the number of firms n_j is independently Poisson distributed with region-specific mean

$$E(n_j) = e^{\alpha + x_j'\beta}. \tag{2}$$

Here too, the parameters β can be estimated by maximum likelihood. As originally pointed out by Guimaraes *et al.* (2003), the log likelihood functions for the conditional logit and the Poisson models are identical up to a constant, and maximum likelihood estimation therefore yields identical parameter estimates $\hat{\beta}$.

The expected share of firms in region j can be written as

$$P_j = \frac{E(n_j)}{\sum_{i=1}^{J} E(n_i)} = \frac{e^{\alpha + x_j'\beta}}{\sum_{i=1}^{J} e^{\alpha + x_i'\beta}} = \frac{e^{x_j'\beta}}{\sum_{i=1}^{J} e^{x_i'\beta}}, \tag{3}$$

which is exactly the same expression as (1), for the conditional logit model.

In the Poisson model, new firms are non-rivalrous, in the sense that adjustment to one regions's locational characteristics works not through changes in firm numbers among the $J - 1$ other regions but from changes either in the supply of local entrepreneurship or in firms attracted from or repelled to somewhere outside the explicitly considered set of J regions. Using (2), we find that $E(n) = \sum_{j=1}^{J} E(n_j) = \sum_{j=1}^{J} e^{\alpha + x_j'\beta} = e^\alpha \sum_{j=1}^{J} e^{x_j'\beta}$. In contrast to the conditional logit model, the expected total number of firms is now not generally equal to the observed total number of firms, N, but depends on regressors and parameters.[4] The Poisson model thus implies that a change in a region's locational attractiveness will affect the sum of firms active in the J regions.

In the *nested logit* model (McFadden, 1978), firms make two sequential choices. At the first stage, they choose between locating in one of the J regions of interest (which could stand for "domestic" regions) and an outside option $j = 0$ (which could stand for locating "abroad" or for remaining inactive). At the second stage, they choose one location among the J regions. Like in the conditional logit model, firm f's profit in region $j > 0$ is determined by a linear function of the region-specific characteristics, such that $\pi_{fj} = x_j'\gamma + \nu_{fj}$. Profits associated with the outside option are given by $\pi_{f0} = \delta + \nu_{f0}$, where δ summarizes the exogenously determined locational attractiveness of the outside option. The stochastic term ν_{f0} is assumed to follow a generalized extreme value distribution, ν_{f0} and ν_{fj} are assumed to be independent. The correlation correlation across ν_{fj} for all $j > 0$ is assumed to be non-negative and constant over time. It is written as $(1 - \lambda^2)$, such that the parameter λ measures the importance of the domestic nest as a whole relative to the outside option.

The probability that a particular firm f chooses a particular region $j > 0$ among the J regions of interest is

$$P_j = \frac{e^{x_j'\beta}(\sum_{i=1}^{J} e^{x_i'\beta})^{\lambda - 1}}{e^\delta + (\sum_{i=1}^{J} e^{x_i'\beta})^\lambda} = P_{j>0} \cdot P_{j|j>0},$$

where $\beta = \gamma/\lambda$. The choice probabilities P_j can be decomposed into (a) the probability of choosing any of the J regions, $P_{j>0} = 1 - P_0$, and (b) the probability of choosing a specific

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[4]Note that the predicted total number of firms *at the estimated coefficients and actual data* corresponds to the observed total of firms in the Poisson model just as it does in the conditional logit model. In symbols, $E(n|\hat{\alpha}, \hat{\beta}) = N$.
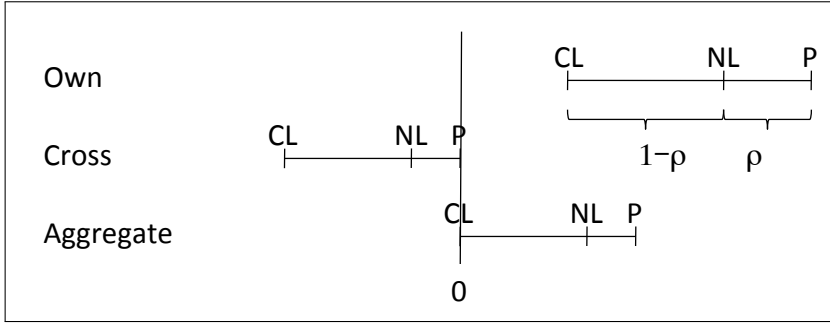
Figure 1: Elasticities Implied by Different Models
Notes: CL = conditional logit, NL = nested logit, P = Poisson

region j given that the firm chooses to set up in one of the J regions,

$$P_{j|j>0} = \frac{e^{x_j'\beta}}{\sum_{i=1}^{J} e^{x_i'\beta}}.$$ (4)

The parameters β can again be estimated by maximum likelihood. The expected total number of firms active in the J regions is simply given by the share of potential firms that decide to become active in one of those regions:

$$E(n) = (n + n_0)\frac{(\sum_{j=1}^{J} e^{x_j'\beta})^\lambda}{e^\delta + (\sum_{j=1}^{J} e^{x_j'\beta})^\lambda} = (n + n_0)P_{j>0}.$$ (5)

As in the Poisson model, the expected total number of firms is not generally equal to the observed total number of firms, N, but depends on the regressors and parameters, including those for the outside option.[5]

In order to compare the three models, we define the *rivalness parameter* $\rho = 1 - \lambda P_0$, which satisfies $0 \geq \rho \geq 1$ under the standard nested logit assumption $0 < \lambda \leq 1$. The parameter ρ offers a measure of where the data generating process lies between the two polar cases, conditional logit ($\rho = 1$) and Poisson ($\rho = 0$). One may think of ρ as capturing of the relative importance of the outside option: as $\rho \to 0$, competition among the J regions becomes unimportant relative to the weight of the outside option. Figure 1 summarizes the relationship between the three models.

3.3 Case B: industry-specific locational determinants

Suppose now that we observe K characteristics x_{sj} for every industry s and region j. Hence, we again do not observe firm-specific attributes, but we now allow for attributes to differ across *groups* of firms, thought of as industries. We maintain the notation x_j for the subset of

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[5]As in the Poisson and conditional logit models, the predicted total number of firms among the J regions *at the estimated coefficients and actual data* corresponds to the observed total: $E(n|\hat{\beta}, \hat{\delta}, \hat{\lambda}) = N$.

locational determinants that are constant across industries. Furthermore, n_{sj} is the number of firms in industry s and region j.

The *grouped conditional logit* model is given by the probability that a given firm f of industry s chooses region j rather than another region:

$$P_{j|f} = P_{j|s} = \frac{e^{x'_{sj}\beta}}{\sum_{i=1}^{J} e^{x'_{si}\beta}},$$

where $P_{j|s}$ is the probability for a particular firm to choose region j, given that the firm belongs to industry s, and $\sum_j P_{j|s} = 1$.

The *grouped Poisson* model is given by

$$E(n_{sj}) = e^{\alpha_s + x'_{sj}\beta},$$

where α_s is an industry-specific constant.

Finally, the *grouped nested logit* model is given by the probability that a given firm f of industry s chooses either the outside option $j = 0$, or a particular domestic region $j > 0$:

$$P_{j|s} = \frac{e^{x'_{sj}\beta}(\sum_{i=1}^{J} e^{x'_{si}\beta})^{\lambda-1}}{e^{\delta_s} + (\sum_{i=1}^{J} e^{x'_{si}\beta})^{\lambda}} = P_{j>0|s} \cdot P_{j|j>0 \cdot s} = (1 - P_{0|s})P_{j|j>0 \cdot s},$$

where δ_s is an industry-year-specific constant. $P_{j>0|s} = 1 - P_{0|s}$ is the probability that a given industry-s firm chooses any domestic region $j > 0$, and

$$P_{j|j>0 \cdot s} = \frac{e^{x'_{sj}\beta}}{\sum_{i=1}^{J} e^{x'_{si}\beta}} \tag{6}$$

is the probability that such a firm chooses a particular domestic region conditional on not choosing the outside option.

As in Case A, the three models are observationally equivalent in a cross-section of domestic firm choices and yield identical estimates for the parameter vector β, but the implied elasticities of the aggregate firm number relative to region-specific attributes are qualitatively different.

4   Estimation

As the likelihood functions of the conditional logit, the nested logit and the Poisson models are identical up to a constant term, estimation of any of the three models will yield identical parameter vectors β in cross-section data. Hence, the three models are observationally equivalent, and the rivalness parameter ρ is not identified (though irrelevant for the estimation of

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β). It is impossible to discriminate between the three models based on a cross-section of data.

If, however, we were able to observe how the total number of firms, N, reacts to changes in the relevant j-level policy variables, *ceteris paribus*, we would be able to distinguish between the three models. Panel data on changes in firm counts or capital stocks could therefore provide the key to identifying elasticities and to answering the ultimate question of whether policy competition is zero sum or positive sum.

4.1 Case A

We begin by considering Case A, i.e. by abstracting from the industry dimension. In the nested logit model, the local linear approximation of the response by the total number of firms n to a simultaneous (small) change of the explanatory variable x_{jk} in all regions $j = 1, 2, ..., J$ is given by the total differential:

$$d \log E(n) \cong \sum_j \frac{\partial \log E(n)}{\partial x_{jk}} dx_{jk} = (1-r)\beta_k \sum_j P_{j|j>0} dx_{jk} = (1-r)\beta_k \overline{dx}_k, \qquad (7)$$

where $E(n)$ is the expected total number of firms (see equation 5), $d \log E(n)$ is the corresponding log change, P_j is the probability that firms choose region j, x_{jk} is the value of the explanatory variable k, and dx_{jk} the corresponding change. $\overline{dx}_k = \sum_j P_{j|j>0} dx_{jk}$ is the average of changes in x_{jk} weighted by the predicted size of locations j, and r is the time-invariant estimated counterpart to the rivalness parameter ρ. In the conditional logit model ($r = 1$), the aggregate response is $d \log E(n) = 0$, whereas in the Poisson model, it is $d \log E(n) = \beta_{kt} \overline{dx}_k$.

Equation (7) suggests the following estimable relationship using a panel of observations of several years t:

$$d \log n_t = c + (1-r) \cdot \beta_{kt} \overline{dx}_{kt} + u_t, \qquad (8)$$

where u_t are i.i.d. shocks to n_t.[6]

Equation (8) has an intuitive meaning beyond the specific derivation we present: the relevant variable that explains aggregate changes in response to simultaneous changes in all regions is a weighted average of the regional changes. The weights are the number of firms in the regions. However, instead of taking the realized number of firms (which would be endogenous by construction) our analysis shows that one should take the expected number.

Equation (8) can be estimated by the following two-step procedure:

First Step

- For all t, estimate $\hat{\beta}_t$ with maximum likelihood (conditional logit or Poisson).

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[6] Additive i.i.d. shocks imply that $\log n_t$ follows an integrated process of order 1.

- For all t and j, predict the choice probabilities $\hat{P}_{jt|j>0\cdot t} = e^{x'_{jt}\hat{\beta}_t} / \sum_{i=1}^{J} e^{x'_{it}\hat{\beta}_t}$.

- For all t, compute $\widehat{\beta_t \overline{dx}_{kt}} = \hat{\beta}_t \sum_j \hat{P}_{jt|j>0\cdot t} dx_{jkt}$.

Second Step

- Regress $d\log n_t$ on $\widehat{\beta_t \overline{dx}_{kt}}$.

Inference at the second step will have to take account of the fact that the independent variable is estimated. This can be done by bootstrapping both steps.

Note that the first step of this procedure amounts to a theory-based method of weighting region-level changes in the policy variable of interest x_k, yielding a measure of the relevant aggregate change in that variable. Our approach therefore offers an alternative to the atheoretical weighting schemes used in previous research, typically based on distance (e.g. Chirinko and Wilson, 2008; Wilson, 2009), or on region size (e.g. Goolsbee and Maydew, 2000).

In general, net growth of the firm stock will depend on many factors other than the policy variable of interest x_k, such as the business cycle, changes in other domestic policy variables, changes in the international environment or a general time trend. To ignore such additional determinants would likely bias the estimate of r. Consistent estimation of the non-rivalness parameter r therefore boils down to the standard problem of identifying the effect of a change in $\widehat{\hat{\beta}_t \overline{dx}_{kt}}$. This is either achieved by properly controlling for all potential determinants of the dependent variable, or by finding instrument for $\widehat{\hat{\beta}_t \overline{dx}_{kt}}$.

4.2 Case B

The use of panel data with an industry dimension in addition to the time and regional dimensions could offer further scope for the identification of r. If the dependent variable is industry specific, the estimation equation becomes:

$$d\log n_{st} = c_s + (1 - r_s) \cdot \beta_t \overline{dx}_{kt} + u_{st}, \tag{9}$$

where the estimated rivalness parameter r_s and the constant c_s can be industry specific, thus controlling for unobserved time-invariant industry characteristics. Furthermore, if there were some omitted variable that biases the estimation of all r_s, the ranking of r_s across industries could still offer unbiased estimates of the *relative* proximity of individual industries to the conditional logit (zero-sum) or Poisson (positive sum) frameworks.

In case the independent variable dx_{sjkt} and/or the location choice parameters β_s are industry specific, the equation becomes

$$d\log n_{st} = c_s + c_t + (1 - r_s) \cdot \beta_{st} \overline{dx}_{skt} + u_{st}, \tag{10}$$

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such that we are in addition able to introduce time fixed effects c_t which control for exogenous growth factors common to all industries.

5 Empirical estimates

5.1 Data

We apply our two-stage panel estimation method to explore the impact of state-level corporate taxation on U.S. inward FDI over the 1977-2006 time period. The dependent variable is defined as annual changes in state-level FDI by sector or by origin country. This setup corresponds to Case B, where we estimate multiple rivalness parameters. FDI is measured alternatively as employment, physical capital stock or number of plants controlled by non-US multinational firms (see Table 1 for summary statistics). Our main explanatory variable is the user cost of capital, as computed for each state and year by Chirinko and Wilson (2008). This variable represents the best available measure of corporate tax burdens, as it captures differences in tax schedules and exemptions and it is adjusted for the extent to which state taxes are deductible from federal taxes and vice-versa. See Chirinko and Wilson (2008) for details.

In addition, we control for the following state-year covariates in the second-step regressions: state government construction spending, median wages, share of working-age population with a third-level degree, median rent for a 2-3 bedroom house, the log of market potential (inversely distance weighted state GDPs), and the log of state population. Due to breaks in the construction of the FDI data series, we furthermore include dummy variables for the years 1987, 1992, 1997 and 2002.

5.2 Results

In Table 2, we show estimates of the estimated rivalness parameter $\hat{r}$ across the six broad industries distinguished in the data. In the pure positive-sum world implied by a Poisson model, the tax base is non-rival and $\hat{r}$ would thus be equal to zero. Conversely, in a zero-sum world as assumed by the conditional logit, $\hat{r}$ would be equal to one. For this reason, we report tests of the hypotheses $r = 0$ and $r = 1$ in the last two columns of Table 2.

An estimated value of r outside the interval $(0, 1)$ would reject our model. While we obtain some point estimates outside that range, we can reject the hypothesis that $r \in (0, 1)$ for none of them.

At the standard significance threshold of 5 percent, we cannot reject the hypothesis $r = 1$ either in any of our estimation runs. This means that our data do not reject the zero-sum assumption.

In four estimation runs, however, we can reject the hypothesis $r = 0$ at the 5-percent level. Hence, the data are favorable to the hypothesis that inward FDI is a rival resource for US states – one state's gain is, to some extent, the other states' loss. In no case do our estimations suggest that FDI could be perfectly rival (i.e. $r = 1$).

When looking at differences across sectors, we find the estimated rivalness parameters to be most precisely measured and relatively high in the manufacturing sector. Taken at face value, this implies that foreign investors in manufacturing ignore state-level tax burdens when deciding on how much to invest in the United States but consider the tax burden when picking a state within the US.

Table 3 reports results based on the differentiation of FDI flows across origin countries. In this case, FDI is measured by counts of foreign-controlled establishments. Again, we never reject the model, i.e. the hypothesis that $r \in (0, 1)$. Another parallel is that we never reject perfect rivalness ($r = 1$), but in once case we reject perfect non-rivalness ($r = 0$). Again, the data are more supportive of the rivalness assumption.

Considerable care is evidently warranted in the interpretation of these results. The standard errors are relatively large. In several cases, the estimated rivalness parameters even lie outside the admissible $(0, 1)$ range (although not statistically significantly so). Nonetheless, our results are rather more favorable to the zero-sum hypothesis than to the pure positive-sum hypothesis.

6   Concluding Discussion

Economists and policy makers devote considerable effort to estimating the impact of regional initiatives aimed at attracting firms or lucrative tax payers. For example, there is now solid empirical evidence for the entirely unsurprising result that low corporate taxes attract firms and employment. A closely related and equally important question is much less frequently asked: where do firms and jobs attracted by fiscal inducements come from? If one region's gain is just another region's loss, then competition among regions is a zero-sum game over a "cake" of fixed size. Conversely, if one region's gain does not come at the expense of any other region, then competition is positive-sum: the size of the total "cake" grows if one region enhances its attractiveness.

We have pointed out that the two standard models for estimating the determinants of firms' location choices although often used interchangeably are in fact fundamentally different. The conditional logit model implies a pure zero-sum world, while the Poisson model implies a pure positive-sum world. This distinction can be important for interpreting the size of estimated policy effects, particularly when considering policy actions by large regions. More importantly,

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the distinction can be used as a tool to estimate the degree to which the object over which regions compete - be it firms, portfolio capital, wealthy individuals, or whatever - is "rival". In other words, we can estimate how close a certain set of regions is to a zero-sum economy or, equivalently, to a positive-sum economy.

Applying our new estimation tool to data on US states, we conclude that in terms of their effect on inward FDI, the effect of tax differentials within the United States conforms more closely with the zero-sum view than with the positive-sum view. This implies that state-level corporate taxes affect only the distribution of FDI across US states but possibly not the total amount of FDI into the country as a whole. Inward FDI appears to be a rival resource.

Our empirical analysis is still somewhat rudimentary, given the relatively small sample size and the difficulty of controlling for all possible covariates (such as non-tax policies targeted at foreign investors). This exercise should therefore first and foremost highlight the relevance of the question on the aggregate effects of decentralized economic policy making in federal systems.

We should finally note that even if we could establish conclusively that certain types of competitive regional policies are zero-sum or positive-sum, we thereby still would not have the answer to the questions whether such competitive policy making is desirable or not. Tax competition can potentially be welfare improving even if it is zero-sum, that is even if the size of the total tax base is given. This would in particular be the case if regional governments were "Leviathans" that would overtax their citizens if they were not held in check by the pressures of tax competition (Brennan and Buchanan, 1980). Conversely, positive-sum competition need not be an unequivocal blessing. If low regional taxes stimulate more local entrepreneurship or hiring, then that is most likely welfare enhancing. If, however, those attractive policies were to pull resources not from other regions of the same country but from other countries, then what would appear as positive-sum competition within a given country could in fact amount to zero-sum competition at the international level.

In sum, it strikes us as important (as well as scientifically challenging) to ask not only "how much economic activity will my regional policy manage to attract?", but also "where will that additional activity come from?" The desirability of political decentralization may depend on the answer to that second question.

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Table 1: Summary Statistics

	Mean	Standard deviation	Min.	Max.
FDI (employment)	20.06	49.44	0.00	749.40
FDI (capital stock)	2,775.36	7,919.27	0.00	121,040.00
FDI (plants)	121.83	257.83	0.00	4048
User cost of capital	0.25	0.01	0.21	0.36
State government construction spending	0.80	0.95	0.03	8.82
Median wage	507.40	54.53	387.30	818.31
Share of working-age pop. with 3rd-level degree	0.24	0.06	0.09	0.52
Median house rent	543.91	165.76	301.37	1497.20
Market potential (in logs)	9.52	0.66	7.09	11.91
Population (in logs)	14.96	1.01	12.71	17.41

Annual state-level data from 1977 to 2006. FDI data from Bureau of Economic Analysis (BEA), tax data and controls from Chirinko and Wilson (2008).

Table 2: Estimated Rivalness of US Inward FDI by Industry

	Rivalness Parameter		Tests (*p*-value)	
	Estimated *r*	stand. error	H0: *r* = 1	H0: *r* = 0
FDI in terms of <u>employment</u>				
All industries	1.01	0.44	0.981	0.036
Finance & Insurance	0.39	0.97	0.538	0.695
Manufacturing	0.86	0.21	0.514	0.001
Other Industries	-0.01	0.76	0.208	0.992
Real Estate	0.23	0.42	0.086	0.593
Retail Trade	0.68	0.53	0.554	0.221
Wholesale Trade	0.78	0.17	0.203	0.000
FDI in terms of <u>physical capital</u>				
All industries	0.28	0.45	0.133	0.551
Finance & Insurance	0.58	0.59	0.483	0.342
Manufacturing	0.93	0.27	0.792	0.004
Other Industries	-1.20	1.68	0.211	0.485
Real Estate	0.81	0.39	0.626	0.056
Retail Trade	0.99	1.27	0.995	0.448
Wholesale Trade	-6.92	4.19	0.080	0.121

Results from a two-step estimation procedure using panel data from 1977 to 2006. The rivalness parameter *r* measures whether FDI gains from a tax reduction in one state equal the total FDI losses of the other states ($r = 1$), reduce FDI in other states to a limited extent ($0 < r < 1$), or do not affect the amount of FDI flowing to other states at all ($r = 0$). Coefficients on control variables not shown. FDI data from Bureau of Economic Analysis (BEA), tax data and controls from Chirinko and Wilson (2008).

Table 3: Estimated Rivalness of US Inward FDI by Country of Origin

	Rivalness Parameter		Tests (*p*-value)	
	Estimated *r*	stand. error	H0: *r* = 1	H0: *r* = 0
FDI in terms of <u>establishment numbers</u>				
All origins	1.04	0.50	0.936	0.055
Canada	1.06	0.55	0.914	0.074
Latin America	0.73	0.29	0.381	0.026
Japan	0.72	0.23	0.122	0.019
Middle East	0.28	0.67	0.302	0.683
France	1.92	2.23	0.686	0.404
Germany	0.54	0.79	0.568	0.502
United Kingdom	-0.04	2.08	0.627	0.987

Results from a two-step estimation procedure using panel data from 1977 to 2006. The rivalness parameter *r* measures whether FDI gains from a tax reduction in one state equal the total FDI losses of the other states ($r = 1$), reduce FDI in other states to a limited extent ($0 < r < 1$), or do not affect the amount of FDI flowing to other states at all ($r = 0$). Coefficients on control variables not shown. FDI data from Bureau of Economic Analysis (BEA), tax data and controls from Chirinko and Wilson (2008).

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