Estimating the Rivalness of State-Level Inward FDI*

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Forthcoming in the *Journal of Regional Science*

Accepted October 15, 2013

Abstract

We develop a method for estimating the rivalness of tax bases using the structures of the conditional logit, Poisson and nested logit models. As an illustration, we apply this method to estimate the effect of state-level capital taxation on U.S. inward foreign direct investment. The assumption of perfect non-rivalness can in some cases be rejected, but the assumption of perfect rivalness cannot. Competition over FDI across U.S. states could well be a zero-sum game.

JEL Classification: C25, R3, H73

Keywords: firm location, FDI, conditional logit, nested logit, Poisson count model

*We thank Bob Chirinko and Dan Wilson for allowing us to use their data, and Charles van Marrewijk (the editor), two anonymous referees, and participants at the 2011 Annual Meeting of the Urban Economics Association in Miami for useful comments. We gratefully acknowledge financial support from the Barcelona Institute of Economics (IEB), and from the Swiss National Science Foundation (Sinergia Grant 130648; and NCCR "Trade Regulation")

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1 Introduction

If governments compete over mobile investment but the overall amount of this investment is fixed, then competition may add nothing to aggregate activity, and governments effectively engage in a zero-sum or even negative-sum game. Conversely, that same competition will represent a positive-sum game if it increases aggregate investment, either by stimulating activity that would otherwise not exist or by attracting investment from outside the territory considered.

In this article, we point out a new way of discriminating empirically among these competing models of investment location, exploiting a fundamental difference between conditional logit and Poisson estimation, and the link provided by the nested logit model. Panel data can allow us to identify the degree of rivalness of local capital stocks via the nested logit approach. We take this method to data for inward foreign direct investment (FDI) in the United States, using state-level statistics from the Bureau of Economic Analysis and exploiting policy variation measured through the user cost of capital. Our results suggest that state-level FDI inflows are rival: 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 investment location has so far largely overlooked the nation-wide implications of local policies.[1] It has been standard to rely on McFadden's (1974) conditional logit model, which offers a formally rigorous way to derive an estimable empirical model of locational determinants from the objective function of a representative location-seeking firm. A similarly popular empirical approach has been to use Poisson count estimation.[2] Guimaraes, Figueiredo and Woodward (2003) have demonstrated 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 coefficient estimates resulting from the two estimation strategies in fact have fundamentally different economic implications. The conditional logit implies that the aggregate amount of investment is fixed and that inter-state 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 state has no

[1]Interestingly, the small number of existing studies that take account of cross-state effects, even though different from ours in terms of data and estimation method, all report competition for mobile capital among US states to be essentially zero-sum (Head, Ries and Swenson, 1999; Goolsbee and Maydew, 2000; Chirinko and Wilson, 2008; Wilson, 2009).

[2]Prominent applications of the conditional logit model include Carlton (1983), Head, Ries and Swenson (1995, 1999), Guimaraes, Figueiredo and Woodward (2000), and Devereux, Griffith and Simpson (2007). The Poisson model has been applied by, among others, Papke (1991), Becker and Henderson (2000), List (2001), Gabe and Bell (2004), Guimaraes, Figueiredo and Woodward (2004) and Brülhart, Jametti and Schmidheiny (2012).

impact on investment in the remaining state and thus raises the national stock of capital by one unit. 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 propose a "rivalness factor" 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. In Section 2, 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 3. Section 4 concludes.

2 The rivalness factor

Standard economic models predict that a corporate tax cut in a particular region, *ceteris paribus*, will lead to an inflow of firms to that region. This inflow, however, could stem from different sources. New firms could be attracted away from other domestic regions. We call this a zero-sum game, where one region's gain is another region's loss. Alternatively, the new firms could be new business activity, or they could be attracted from abroad. We consider these cases as corresponding to a positive-sum game, where a positive stimulus in one region leads to an increase in the country-wide number of firms. The rivalness factor – contained between zero and one – covers all intermediate cases between the zero-sum game, which implies full rivalness, and the fully non-rival variant of positive-sum games.

Researchers to date have taken account of this factor by exploring the effect of a region's policies on neighbouring regions.[3] This approach implicitly takes account of the fact that the degree of rivalness is likely to be strongest at short distances, but it requires the definition of largely arbitrary cutoffs defining who counts as a "neighbour". Our approach does away with the need for such *ad hoc* choices, at the cost of not taking account of the spatial configuration of regions.

We now formally derive the rivalness factor. For ease of exposition, we consider location choices of equally sized single-location firms, and we begin by abstracting from the time dimension. We 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, summed across all domestic regions, whereas N denotes the observed total number of firms.

Suppose that determinants of locational attractiveness are purely region specific, and that firm f's profits in region j are 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

[3] See references in footnote 1.

coefficients.

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 is given by $P_j = e^{x_j'\beta}/\sum_{i=1}^{J} e^{x_i'\beta}$, where $\sum_j P_{j|f} = 1$ for all f.

This model implies that the total number of firms n is independent of 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: $E(n) = \sum_{j=1}^{J} E(n_j) = n = N$. Hence, any change in an explanatory variable x_{jk} in location j has no effect on the total number of firms:

$$\frac{\partial \log E(n)}{\partial x_{jk}} = 0 \tag{1}$$

The *Poisson* estimator is based on the assumption that the number of firms n_j is independently Poisson distributed with region-specific mean $E(n_j) = e^{\alpha + x_j'\beta}$.

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] Specifically, $E(n) = \sum_{j=1}^{J} E(n_j) = \sum_{j=1}^{J} e^{\alpha + x_j'\beta} = e^{\alpha} \sum_{j=1}^{J} e^{x_j'\beta}$. The Poisson model thus implies that a change in a region's locational attractiveness x_{jk} will affect the sum of firms active across the J regions:[5]

$$\frac{\partial \log E(n)}{\partial x_{jk}} = \frac{e^{x_j'\beta}}{\sum_{i=1}^{J} e^{x_i'\beta}} \beta_k = \frac{E(n_j)}{E(n)} \beta_k = P_j \beta_k. \tag{2}$$

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 domestic regions and the outside option $j = 0$, which stands for locating abroad or remaining inactive. At the second stage, they pick one of the J regions. Like in the conditional logit model, firm f's profits in region $j > 0$ are 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, where ν_{f0} and ν_{fj} are assumed to be independent. The correlation across ν_{fj} for all $j > 0$ is assumed to be non-negative and constant over time. It is written as $\left(1 - \lambda^2\right)$, such that the parameter λ measures the importance of the domestic "nest" as a whole relative to the outside option.

[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, $E(n|\hat{\alpha}, \hat{\beta}) = N$.

[5] We define $P_j \equiv E(n_j)/E(n) \neq E(n_j/n)$ in the Poisson model. Using this definition, $P_j = e^{x_j'\beta}/\sum_{i=1}^{J} e^{x_i'\beta}$ in both the conditional logit and the Poisson model.

The probability that a particular firm f chooses a particular domestic region $j > 0$ is $P_j = [e^{x_j'\beta}(\sum_{i=1}^J e^{x_i'\beta})^{\lambda-1}]/[e^\delta + (\sum_{i=1}^J e^{x_i'\beta})^\lambda] = P_{j>0} \cdot P_{j|j>0}$, where $\beta = \gamma/\lambda$, while the probability of choosing the outside option is $P_0 = e^\delta/[e^\delta + (\sum_{j=1}^J e^{x_j'\beta})^\lambda]$. The choice probabilities P_j can be decomposed into (a) the probability of choosing any of the J domestic regions, $P_{j>0} = 1 - P_0$, and (b) the probability of choosing a specific region j given that the firm chooses to locate in the country, $P_{j|j>0} = \frac{e^{x_j'\beta}}{\sum_{i=1}^J e^{x_i'\beta}}$. The expected total number of firms active across the J regions is given by the share of potential firms that decide to become active in one of those regions $E(n) = n_{pot}[(\sum_{j=1}^J e^{x_j'\beta})^\lambda]/[e^\delta + (\sum_{j=1}^J e^{x_j'\beta})^\lambda] = n_{pot}P_{j>0}$. The number of potential firms, $n_{pot} = n + n_0$, is a parameter of the nested logit model, while the number of firms choosing the outside option, n_0 and the number of firms choosing a domestic region, n, are determined by the model. Hence, n_{pot} represents the latent maximum number of firms that could conceivably be attracted to the domestic country. In the nested logit model, a change in a region's locational attractiveness x_{jk} will affect the sum of firms active across the J regions by:

$$\frac{\partial \log E(n)}{\partial x_{jk}} = \frac{\lambda e^\delta e^{x_j'\beta}(\sum_{i=1}^J e^{x_i'\beta})^{-1}\beta_k}{e^\delta + (\sum_{i=1}^J e^{x_i'\beta})^\lambda} = \lambda P_0 P_{j|j>0}\beta_k = (1-\rho)P_{j|j>0}\beta_k. \tag{3}$$

We define the rivalness factor as $\rho = 1 - \lambda P_0$, which satisfies $0 \leq \rho \leq 1$ under the standard nested logit assumption $0 < \lambda \leq 1$. For $\rho \to 1$, the effect (3) reduces to the one in the conditional logit model (1) and for $\rho \to 0$, it reduces to the effect in the Poisson model (2). 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.

3 Estimation

In the nested logit model, the local linear approximation of the response by the total number of firms n_t in year t to a simultaneous (small) change of the explanatory variable x_{jkt} in all regions $j = 1, 2, ..., J$ is given by the total differential:

$$d\log E(n_t) \cong \sum_j \frac{\partial \log E(n_t)}{\partial x_{jkt}} dx_{jkt} = (1-\rho_t)\,\beta_{kt}\sum_j P_{jt|j>0}dx_{jkt} = (1-\rho_t)\,\beta_{kt}\overline{dx}_{kt}, \tag{4}$$

where $E(n_t)$ is the expected total number of firms across the J domestic regions, $d\log E(n_t)$ is the corresponding log change between $t-1$ and t, P_{jt} is the probability that firms choose region j in year t, x_{jkt} is the value of the explanatory variable k, and dx_{jkt} the corresponding change. $\overline{dx}_{kt} = \sum_j P_{jt|j>0}dx_{jkt}$ is the average of changes in x_{jkt} weighted by the predicted size of regions j. The rivalness factor is $\rho_t = 1 - \lambda e^\delta/[e^\delta + \left(\sum_i e^{x_{it}'\beta_t}\right)]$ and depends in general on the parameters λ and δ as well as on the time-varying explanatory variables x_{jkt}. We shall assume that the outside option (locating abroad or remaining inactive) is large, by letting $\delta \to \infty$. Thus, the rivalness factor reduces to $\rho_t = 1 - \lambda$, making it time invariant.

Equation (4) suggests the following estimable relationship using a panel of observations of several years t:

$$d \log n_t = c + (1 - \rho) \cdot \beta_{kt} \overline{dx}_{kt} + u_t, \tag{5}$$

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

Equation (5) 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 of firms, which is entirely based on exogenous information.

Equation (5) 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).[7]
- 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 $\overline{dx}_{kt}$ 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,

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

[7] In all three models (conditional logit, Poisson, and nested logit), the parameters β_t are estimated by maximizing the same (concentrated) likelihood function (see Schmidheiny and Brülhart, 2011):

$$\log L(\beta) = \sum_{j=1}^{J} N_j x'_j \beta - \sum_{j=1}^{J} [N_j \log(\sum_{i=1}^{J} e^{x'_i \beta})].$$

changes in the international environment or a general time trend. Consistent estimation of the rivalness factor ρ 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 $\widehat{\hat{\beta}_t \overline{dx}_{kt}}$.

Additional scope for the identification of ρ will be available where panel data contain an industry dimension in addition to the time and regional dimensions. Denoting industries by s, the estimation equation becomes:

$$d \log n_{st} = c_s + (1 - \rho_s) \cdot \beta_t \overline{dx}_{kt} + u_{st}, \tag{6}$$

where c_s controls for unobserved time-invariant industry characteristics. Furthermore, if there were some omitted variable that biases the estimation of all ρ_s, the ranking of ρ_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.

Finally, in cases where the independent variable dx_{sjkt} and/or the location choice parameters β_s are industry specific, the equation becomes

$$d \log n_{st} = c_s + c_t + (1 - \rho_s) \cdot \beta_{st} \overline{dx}_{skt} + u_{st}, \tag{7}$$

such that time fixed-effects c_t can be added to control for exogenous growth factors common to all industries.

4 Empirical estimates

4.1 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. FDI is measured alternatively in terms of employment, physical capital stock or the 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.[8]

[8] US states compete for mobile capital investment not only through their statutory taxes but also through a range of other fiscal policy instruments, often tailored to individual firms. Story (2012) estimates the total value of such incentives at some USD 80 billion - the equivalent of 10 percent of states' total tax receipts. It would be interesting in future research to try to quantify these policies in the longitudinal dimension.

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.

4.2 Results

Applying the first step of our proposed estimation procedure we estimate inward FDI into U.S. states as a function of the user cost of capital, state government expenditures on construction, the median wage, the share of working-age population with a third-level degree, the median house rent, market potential (in logs) and population (in logs) separately for 30 years and six industries. Including one yearly estimation for the total of all industries, there are 196 estimations. Figure 1 shows the resulting t-statistics for the coefficient on the user cost of capital. The estimates are predominantly (74%) negative, in line with expectations. Only 10 coefficients (6 in real estate, 2 in finance & insurance, 2 in other industries) are statistically significantly positive.

In the second step, we estimate the rivalness parameter $\widehat{\rho}$. Table 2 shows the estimated parameter 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 $\widehat{\rho}$ would thus be equal to zero. Conversely, in a zero-sum world as assumed by the conditional logit, $\widehat{\rho}$ would be equal to one. For this reason, we report tests of the hypotheses $\rho = 0$ and $\rho = 1$ in the last two columns of Table 2.

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

At the standard significance threshold of 5 percent, we cannot reject the hypothesis of perfect rivalness, $\rho = 1$, 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 $\rho = 0$ 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.

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 $\rho \in (0,1)$. Another parallel is that we never reject perfect rivalness ($\rho = 1$), but in once case we reject perfect non-rivalness ($\rho = 0$). 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 factors 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.

5 Concluding Discussion

Economists and policy makers devote considerable effort to estimating the impact of regional incentives aimed at attracting firms or lucrative tax payers. A closely related and equally important question is 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.

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 used as a tool to estimate the degree to which the object over which regions compete - be it firms, portfolio capital or wealthy individuals - is a rival good.

Applying our new estimation tool to data on US states, we conclude that regarding 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 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 results might conceivably be affected by reverse causality, by omitted variables and by heterogeneity of investment projects (Duranton, Gobillon and Overman, 2011). The estimation method proposed in this paper does not intend to solve this issue. Reverse causation and omitted variables could be addressed with standard techniques such as instrumental variables. Unfortunately, the data available for this paper do not provide convincing instruments. We hope in future research to find settings that allow us to deal explicitly with endogeneity.

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 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. 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.

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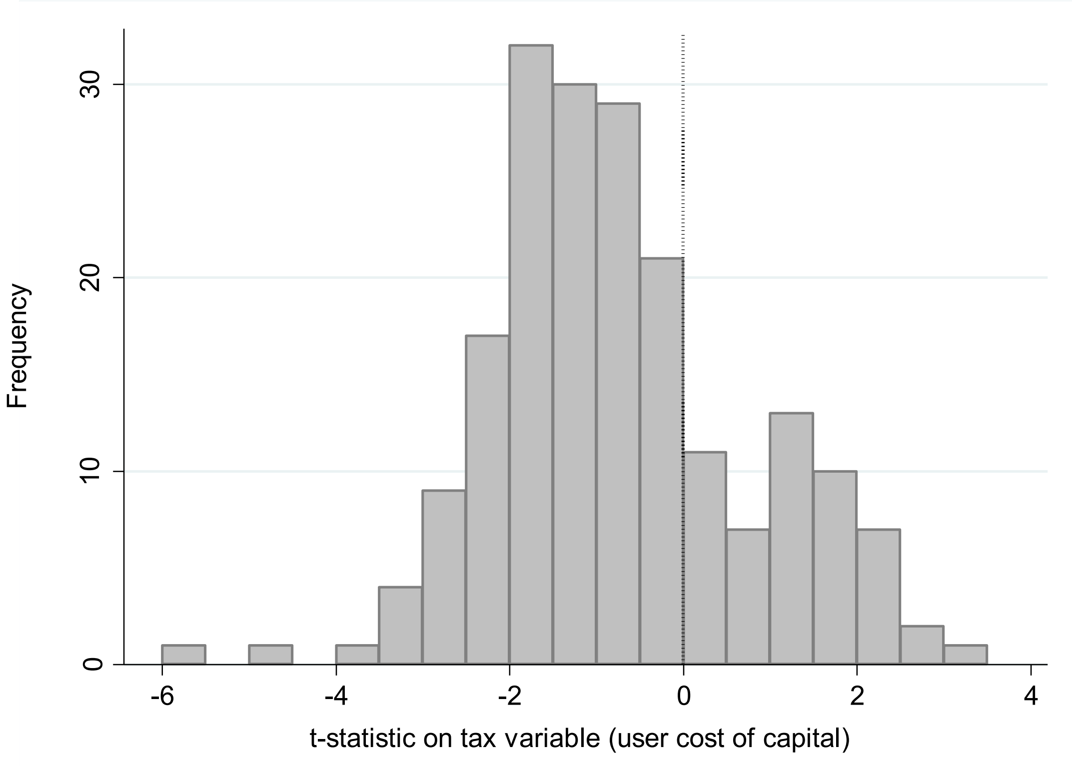
Figure 1: Distribution of t-Statistics on Tax Variable in First-Step Estimations



Coefficients from first-step maximum likelihood estimation. Dependent variable: FDI in terms of employment; explanatory variables: user cost of capital, state government expenditures on construction, median wage, share of working-age population with 3rd-level degree, median house rent, market potential (in logs), population (in logs). 196 estimates (6 industries + total, 28 years); robust standard errors.

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 ρ	stand. error	H0: $\rho = 1$	H0: $\rho = 0$
FDI in terms of employment				
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 physical capital				
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 ρ measures whether FDI gains from a tax reduction in one state equal the total FDI losses of the other states ($\rho = 1$), reduce FDI in other states to a limited extent ($0 < \rho < 1$), or do not affect the amount of FDI flowing to other states at all ($\rho = 0$). 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 ρ	stand. error	H0: $\rho = 1$	H0: $\rho = 0$
FDI in terms of establishment numbers				
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 ρ measures whether FDI gains from a tax reduction in one state equal the total FDI losses of the other states ($\rho = 1$), reduce FDI in other states to a limited extent ($0 < \rho < 1$), or do not affect the amount of FDI flowing to other states at all ($\rho = 0$). Coefficients on control variables not shown. FDI data from Bureau of Economic Analysis (BEA), tax data and controls from Chirinko and Wilson (2008).