Competition for Firms: Zero-Sum or Positive-Sum Game?

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1. Introduction

National and regional governments everywhere compete over footloose firms by devoting considerable resources to investment promotion. Such policies range from advertising campaigns and information dissemination all the way to subsidies and tax breaks.

To the extent that new firms generate positive local externalities, such policies can be efficient from the viewpoint of individual governments. What may 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: they amount to a zero-sum or even negative-sum game. Conversely, those same policies will represent a positive-sum game if they increase aggregate output, either by stimulating economic activity that would otherwise not exist or by attracting productive resources from outside the territory considered. Thus, for example, it is critical from a national point of view whether interregional competition for mobile firms merely determines where among those regions an exogenously fixed number of firms will locate, or whether it will increase the overall number of firms created in the country by attracting them from abroad or by stimulating home-grown corporate ventures.

The empirical literature on firm location has so far largely overlooked this simple but essential distinction. The emphasis to date has been on quantifying the importance of manifold determinants of firm location - an important and challenging identification task in itself. In this, the conventional estimation approach has been to rely on McFadden's 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 recently been 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 implicit premise of the conditional logit model is that the aggregate number of firms is fixed and that intergovernmental competition affects only the distribution of those firms across locations. In the Poisson model, however, the aggregate number of firms is a function of locational determinants, such that an additional firm attracted to one jurisdiction has no impact on the number of firms in the remaining jurisdictions and thus raises the aggregate number of firms by one. We show that intermediate cases between these two extremes can be represented by a nested logit model featuring a generic "outside option".

Here, we point out a new way of discriminating among the competing location models empirically. We show how panel data can allow us to identify the degree of "rivalness" of local policies designed to attract economic activities - through a parameter in a nested-logit model. We take this methodology to data for inward foreign direct investment 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.[1] Preliminary results suggests that state-level competition for FDI is largely zero-sum: the total amount of investment is not significantly affected by differences in tax rates across states, but tax incentives have a significant influence on the distribution of investment across states.

2. Literature Review

The application of the conditional logit model to the estimation of the determinants of firms' location choices was pioneered by Carlton (1983).[2] The Poisson count model was first used in this

[1] The relevant data are obtained from Daniel Wilson (San Francisco Fed).

[2] Prominent subsequent applications include Bartik (1985), Head, Ries and Swenson (1995, 1999), Guimaraes, Figueiredo and Woodward (2000), Figueiredo, Guimaraes and Woodward (2002), Crozet, Mayer and Mucchielli (2004), Head and Mayer (2004), Devereux, Griffith and Simpson (2007), and Strauss-Kahn and Vives (2009).

context by Papke (1991).[3] Guimaraes et al. (2003) then showed that the two approaches yield identical estimates for models that do not feature firm-specific regressors. In the words of Guimaraes et al. (2003), they demonstrated "that the coefficients of the conditional logit model can be equivalently estimated using a Poisson regression" (p. 203), and "that the coefficients of the Poisson model can be given an economic interpretation compatible with the framework of random utility (profit) maximization" (p. 204). While their equivalence result is correct and useful in terms of estimation, we point out in Schmidheiny and Brülhart (2011) that the two models are not equivalent because they 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 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, 2007). Jofre-Monseny and Solé-Ollé (2007) 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 used it as the basis for Poisson estimation of a model of cross-border mergers and acquisitions.[4]

Empirical research on competition over mobile firms 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.[5]

The aggregate implications of uncoordinated policies aimed at attracting mobile firms, however, have remained comparatively underresearched. To the best of our knowledge, all existing empirical studies of this issue are based on competition among US states, and they all conclude 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 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 neighbouring out-of-state effects of US state-level R&D tax credits, concluding that the two effects almost exactly offset each other.

3. A New Method for Identifying the Rivalness of Tax Bases

In Schmidheiny and Brülhart (2011), we show that the three standard location choice models – conditional logit, nested logit and Poisson – are observationally equivalent in terms of cross-section estimation yet imply starkly different predictions. Take a corporate tax cut in a particular region. Provided that this is perceived by firms as making that region more attractive, all three models imply that the region itself will see an increase in its number of firms. We show that the magnitude of the implied increase 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 firm counts in any other of regions within the data set. It will, however, pull firms away from other regions in the conditional logit and the nested logit cases. As the total number of firms is fixed in the conditional logit, the sum of the firms pulled away from the other regions is the same as the increase in the number of firms in the tax-cutting region itself. The nested logit again represents an intermediate case, with some of the attracted firms relocating from elsewhere within the data set, implying that regional corporate tax bases are "rival"; and some firms appearing from outside that set, implying a "non-rival" tax base. The same logic can be applied to residential choices of private households with respect, for instance, to changes in local property tax rates.

This analysis has two practical implications. First, empirical researchers should be aware of the interpretational ambiguity affecting estimated parameters in standard location choice models, particularly if some of the locations distinguished in the data are relatively large. It can therefore be useful to report both conditional logit and Poisson elasticity estimates as bounds on the effects implied by the estimated parameters.

[3] Prominent subsequent applications include Becker and Henderson (2000), List (2001), Guimaraes, Figueiredo and Woodward (2004), and Holl (2004).

[4] 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).

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

Table 1. Effect of Tax Reduction in Single U.S. State on Inward FDI (in terms of 2006 manufacturing employment)

	Large State		Small State	
	California		Rhode Island	
	Cond. Logit	Poisson	Cond. Logit	Poisson
Own Elasticity	13.08%	14.65%	14.59%	14.65%
Cross Elasticity	-1.56%	0%	-0.06%	0%
Aggregate Elasticity	0%	1.56%	0%	0.06%

Source: Results from Poisson regression of new employment from foreign direct investment (FDI) in 49 U.S. states on user cost of capital (tax) and state population. Effect of a one standard deviation reduction in user costs. Own elasticity is the percentage effect on FDI employment in state which reduced tax. Cross elasticity is the percentage effect on FDI employment in other states. Aggregate elasticity is the percentage effect on total FDI employment in all states. FDI employment data from Bureau of Economic Analysis (BEA), tax data from Chirinko and Wilson (2008).

Second, the linear connection of the conditional logit and Poisson models through the nested logit offers an elegant way of quantifying the rivalness of tax bases. In fact, the nested logit model implies a simple parameter that can take any value between zero and one, and which can be interpreted as a "rivalness" parameter. 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 evidently possible as well.

While the rivalness parameter has evident policy relevance and offers a rigorous link to the theory, 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 one 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. The intuition is that 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. We derive how the correct weights for this average can be calculated from the nested logit model.

4. Elasticity Bounds

We show in Schmidheiny and Brülhart (2011) that estimation of the conditional logit, nested logit and Poisson models will yield identical parameter estimates, and that it is impossible to discriminate formally between these three model based on cross-section data. And yet, the implied elasticities differ substantially. In previous research, reported elasticities were based either on the conditional logit model or the Poisson model, without justification of the particular choice made or, mistakenly in this respect, by referring to the equivalence of the two models as established by GFW.

What can researchers do if they are not willing to make this choice by assumption but rely on cross-sectional data? We propose in this situation that one calculate the elasticities of both the conditional logit and the Poisson model and report these predictions as bounds for the true effects.

Such bounds are illustrated above. We take the example of inward foreign direct investment (FDI) across 49 U.S. states (excluding Alaska). From the Bureau of Economic Analysis, we have data on the employment level of foreign-owned plants for eleven industries over the period 1977-2006. In a first step, we regress inward FDI for 2006 on state population and on the "user cost of capital", a carefully constructed measure of the effective corporate tax burden by Chirinko and Wilson (2008). By way of an illustration, we compute the implied coefficients (which could equivalently be obtained via Poisson or conditional logit estimation) for California, a large state, and for Rhode Island, a small state.

The first row of Table 1 shows the predicted percentage change in inward FDI attracted by a given state if that state's corporate tax burden were lowered by one standard deviation, everything else unchanged. As expected, these elasticities are positive: lower taxes attract additional foreign investment in the manufacturing industry. We also see that the Poisson elasticities are somewhat larger than their conditional logit equivalents: in a positive-sum world, the tax base is more elastic than in a zero-sum world. This difference is very small for Rhode Island, but for a large state such as California, the distinction is not trivial, as the implied Poisson elasticity is some 12 percent larger than the implied conditional logit elasticity.

In the second row of Table 1, we show cross elasticities: the effect on FDI of other states if the reference state lowers its corporate

Table 2. Estimated Rivalness of US Inward FDI, by Industry

	Rivalness Parameter		Tests (p-value)	
	Estimated ρ	stand. error	H0: ρ = 1	H0: ρ = 0
Finance & Insurance	1.20	0.17	0.250	0.000
Manufacturing	0.59	0.35	0.259	0.106
Other Industries	1.02	0.53	0.970	0.070
Real Estate	0.45	0.36	0.136	0.219
Retail Trade	0.84	0.68	0.817	0.227
Wholesale Trade	0.54	0.43	0.302	0.223

Source: 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 (ρ = 1), reduce FDI in other states to a limited extent (0 < ρ < 1), or do not affect the amount of FDI flowing to other states at all (ρ = 0). FDI employment data from Bureau of Economic Analysis (BEA), tax data from Chirinko and Wilson (2008).

tax burden by one standard deviation. The cross elasticity is zero in the Poisson model. This of course makes perfect sense: in a pure positive-sum economy, the fact that California attracts more FDI thanks to a reduction in its corporate tax rates leaves the amount of FDI flowing to other states unaffected. In the conditional logit model, however, this effect is negative: the more FDI California manages to attract, the less is left over for the other states.

Another way to illustrate the distinction between zero-sum and positive-sum scenarios implied by the two benchmark models is to look at the predicted elasticity of total US inward FDI relative to a tax cut in one particular state. We do this in the third row of Table 1. In the zero-sum conditional-logit world, the aggregate elasticity is zero: the size of the total FDI cake is given. In the Poisson world, however, the total amount of US inward FDI increases if one state raises its attractiveness to foreign investors. Of course, this effect is stronger for large states than for small states. In the Poisson interpretation, our results imply that if California cuts its corporate tax burden by one standard deviation, this will raise US inward FDI by 1.56 percent. If a small state like Rhode Island were do pursue such a policy, this would have much less of an impact on the national total, raising it by a mere 0.06 percent.

As these illustrations show, the distinction between the zero-sum and positive-sum models may not be very important for small territorial units, but can become non-trivial for larger regions. This raises the question as to which is the more realistic of the two models. We investigate this question in the next section.

5. Rivalness

In Table 2, we show estimates of the "rivalness" parameter ρ, computed through our two-step approach that uses the panel structure of the US FDI data over the 1977-2006 time period. In the pure positive-sum world implied by a Poisson model, the tax base is non-rival and ρ would thus be equal to zero. Conversely, in a zero-sum world as assumed by the conditional logit, ρ 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.

The table shows that we can reject the hypothesis $\rho = 1$ for none of the six sample sectors. This means that our data do not reject the zero-sum assumption. In two of the six sectors, however, we can reject the hypothesis $\rho = 0$, meaning that we can conclude that for those sectors inward FDI is a rival resource for US states – one state's gain is, to some extent, the other states' loss. Hence, our results are somewhat more supportive of the zero-sum model (à la conditional logit) than of the pure positive-sum model (à la Poisson).

When looking at differences across sectors, we find the estimated rivalness parameters to be relatively high in "finance and insurance" and in "other industries". Taken at face value, this implies that foreign investors in these sectors pursue a two stage strategy, first, they decide on how much to invest in the United States, irrespective of state-level tax burdens, and then they pick a state as a function of taxes and of other state characteristics. In sectors with lower rivalness parameters, such as real estate and wholesale trade, investors would seem to take state-level tax policies into account already at the first stage, i.e. when they decide whether to invest in the United States or in some other country.

Considerable care is evidently warranted in the interpretation of these results. The standard errors are relatively large. In two cases, the estimated rivalness parameters even lie outside the admissible zero-to-one range (although not statistically significantly so). For more conclusive evidence, one should control for additional state-level time-varying factors or use instrumental variables. Nonetheless, our results are rather more favourable to the zero-sum hypothesis than to the pure positive-sum hypothesis, which, for a large country such as the United States, appears quite plausible.

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, 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 not the total amount of FDI into the country as a whole. Inward FDI is akin to a rival good.

Our empirical analysis is still somewhat rudimentary, as for a conclusive assessment greater care would need to be taken in controlling for non-tax locational determinants. This exercise should therefore first and foremost highlight the relevance of the question on the aggregate effects of decentralised 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.

To summarise, it is very 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 decentralisation crucially depends on the answer to that second question.

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