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Economic Base in Emerging Economies: Estimating Regional Multipliers in Ecuador

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ECONOMIC BASES IN EMERGING ECONOMIES: ESTIMATING REGIONAL MULTIPLIERS IN ECUADOR

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ABSTRACT

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When a subnational input-output matrix is unavailable, a non-governmental organization (NGO) may turn to a shortcut method in order to project its indirect economic impact in a region. The location quotient is the most common choice in developed nations, but has serious theoretical flaws in a developing-nation context. We explore the minimum requirements method as a cost-effective yet robust method to project the impact of an NGO in the Imbabura province of Ecuador. We find that every $1 of exogenous local spending stimulates between $1.32 and $1.62 of indirect economic impact in the region.

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1 INTRODUCTION

Non-governmental organizations (NGO) face higher expectations that they measure their direct impact on program recipients, yet many miss the opportunity to project the indirect economic impact that their programs stimulate in the local economy. It is possible that NGOs do not see the value of measuring indirect economic impact relative to the cost. After all, the gold standard for forecasting regional multipliers is the subnational input-output (I-O) model, and in the United States the Bureau of Economic Analysis (BEA) provides data necessary to construct these matrices. In developing countries, this statistical infrastructure does not exist, making it extremely costly for an institution to project regional economic impact. If "the value of a simple export-base ratio is fairly low, in the hundreds of dollars," as Schaffer (1999) contends, then it is necessary to find a low-cost shortcut method to project regional economic multipliers. This paper explores the minimum requirements method as the ideal shortcut method for NGOs operating in developing nations to project their indirect economic impact.

1.1 Background

If the value of the regional multiplier to an NGO is high and budget constraints allow, input-output analysis is the soundest option for evaluating the effect of exogenous changes in the local economy. However the data requirements for input-output modeling across regions can be suffocating. Analyzing a model of N sectors and R regions would demand N^2R^2 elements of data, and simplifying assumptions about the interregional flow of goods will only reduce the number of elements to $NR^2 + RN^2$ (Nijkamp, Rietveld, & Snickars, 1986). Aside from the data requirements, the immense amount of time involved in compiling input-output tables can be self-defeating, creating significant lags between the time in which the data were relevant and when they are available (Miller & Blair, 1986). As that gulf widens, the likelihood increases that the production recipes, inter-industry linkages, and labor requirements have evolved. Relative prices, labor-capital substitution elasticities, economies of scale, general macroeconomic conditions, and import coefficients are also unlikely to remain constant after a years-long delay, and new products are also inevitably introduced in that period. All of these developments will undermine the validity of an input-output model. An NGO wishing to project its indirect economic impact can turn to economic-base theory to furnish it with straightforward, inexpensive estimates.

Economic-base theory gives a framework to quickly project regional multipliers without a full regional I-O matrix, but it is only useful insofar as an NGO can accurately demarcate the basic and nonbasic sectors (Garrison 1972). Several 'shortcut' methods have evolved over time to perform this apportionment, but most of these methods are unsuitable for developing nations (Meyer & Pleeter, 1975). Developing regions present challenges that are both theoretical and practical for estimating income and employment multipliers. This research seeks to determine the utility of these shortcut methodologies for estimating regional multipliers in these regions, with an emphasis on the most promising candidate, the minimum requirements method.

1.2 Study Description

This study uses the minimum requirements method to approximate the economic impact of a non-governmental organization working in the Imbabura region of Ecuador. This author worked with the organization, the Institute for Self-Reliant Agriculture (SRA), for several years attempting to measure the direct impact its programs had on nutritional and agronomic outcomes. After institutional factors frustrated the attempt to implement a randomized controlled trial (RCT), we turned to projecting the indirect economic impact from the NGO. To do so, we build on the work of Woller and Parsons (2002a), who estimate the minimum requirements multiplier for Ecuador to project the indirect economic impact of a microfinance NGO, Project HOPE. This paper goes into more depth around the various assumptions underpinning economic-base theory, and gives a step-by-step breakdown with illustrations of how to perform the minimum requirements method. We then apply the minimum requirements method to Ecuador, comparing our estimates to those of the location quotient and previous studies. A Stata do file is included to aid in applying the methodology in future studies.

1.3 Limitations of the Study

The main limitation of this study is the inability to compare the multipliers we generate to "objective" multipliers. If a subnational input-output matrix existed for Ecuador, we could use this as a baseline in order to assess how well the minimum requirements method performs against the more data-intensive but also more precise methods of forecasting regional multipliers. Unfortunately, no such regional I-O matrix exists for Ecuador. We also cannot replicate Woller and Parsons (2002a) exactly, because of incompatibilities between their data and the census in later years. We can compare the distributions of multipliers generated and glean some insight on the strengths and weaknesses of our respective methodologies.

It is important to note that we are estimating the indirect impact due to the expenditures by the NGO in the region of Imbabura, where they purchased agricultural inputs and paid employee salaries. A true estimate of regional impact would include the increase in expenditure by NGO program recipients; unfortunately that is not possible in this study. Additionally, in the absence of precise accounting data from the NGO, we can only report estimates of economic impact per dollar of expenditure, rather than the overall impact. Finally, without a valid counterfactual and times-series data, we cannot validate the causal impact of this NGO on regional income; we must content ourselves with using economic-base methodology to make a rough estimate of how much the NGO created in indirect economic impact.

2 LITERATURE REVIEW

The literature on projecting the indirect economic impact of NGOs using regional multipliers is sparse (Woller & Parsons, 2002b). NGOs feel pressure to measure direct impact on program beneficiaries, but a search of the literature reveals few studies formally estimating indirect impact. This is surprising because projecting indirect impact is certainly cheaper and quicker than conducting a randomized controlled trial (or other quasi-experimental designs) in order to measure direct impact. Any studies that project NGO impact in developing countries rely heavily on an economic-base framework to estimate the regional multiplier.

2.1 Economic-Base Theory

Economic-base theory earns its namesake from a strict dichotomy between two distinct sectors of the economy: nonbasic (local) employment and basic (export) employment. The intellectual heritage of economic base theory is as varied as that of the whole regional economics paradigm. Gibson (2004) remarks that economic base theory "belongs to both economics and geography" (p. 113), and Stabler (1968) describes export-base theory as a blend of location theory and selected parts of international trade theory. More recent theoretical work on economic-base theory is relatively scarce, as regional science has come to favor the more precise input-output and social accounting matrix multipliers. While it is true that the latter methods could represent a vast improvement in generating regional multipliers (see Section 2.4 for a review of the empirical evidence), they also require highly detailed and disaggregated employment and income data. Collecting these data is prohibitively expensive in emerging economies that do not enjoy the same statistical resources as developed economies, particularly at the sub-national level.

Economic base theory has many uses as a descriptive tool unrelated to regional multipliers (Gibson, 2004). For instance, Rodgers (1957) uses an index to approximate industrial diversity similar to a Gini coefficient. Ullman and Dacey (1971) use the minimum requirements method to measure regional specialization. Hoover (1975) suggests that economic base analysis can highlight surplus areas (where supply exceeds local demand) and deficit areas (where the demand outstrips local supply). The Lowry model and spatial interaction land-use simulation models also use basic/nonbasic employment as key parameters for forecasting urbanization (Gonçalves & Dentinho, 2007). The real draw of economic base theory, however, is as a shortcut method to generate regional multipliers. Our interest lies with how an NGO may use an economic-base framework to project its economic impact in a region.

Economic-base theory has persisted despite its simplicity precisely because it can supply a straightforward answer for policymakers who want to assess the impact of a new policy or project on a given region. The means by which economic-base theory can supply projections is explained by the relationship between the economic-base ratio and the multiplier. When there is an exogenous increase in spending in an area, this can raise the level of income and employment in the region by more than just the direct increase. The positive expenditure shock is in turn spent, which is in turn spent again, *ad infinitum*. The overall effect, in the economic-base theory framework, depends on the relative sizes of the regional basic sectors (for exporting to other regions) and nonbasic sectors (for satisfying local demand for goods and services).

An important question is how quickly any multiplier effects will materialize. Timing matters because benefits in the future are less valuable than immediate impacts from a cost-benefit perspective. If taking into account the time value of costs and benefits, the velocity with which indirect economic impacts materialize is crucial. Several authors find large lags between increases in basic activity and multiplier effects, and even contend that the economic base multiplier can be negative in the short run (Jurado, 1980). Moody and Puffer (1970) estimated that indirect multiplier impacts would take decades to materialize. McNulty (1977) estimates that economic base impacts had taken several years to materialize over the period from 1950 to 1969 based on a BEA dataset covering 41 SMSAs in the US. However, Gerking and Isserman (1981) expose a serious flaw in the estimation strategy, and argue that his results in fact “tend to support the hypothesis that basic activity immediately affects nonbasic activity” (p. 454) within a one- to three-year time frame. Sinclair and Sutcliffe (1982) track the first and second round expenditures due to tourism activity in a Spanish resort area and find that the expected multiplier effect for just these two rounds takes four years to materialize. The time to realize multiplier impacts is critical; two identical but mutually exclusive NGO projects may in fact have different impacts on overall economic welfare due to the difference in the timing of multiplier, an important point to take into consideration when forecasting regional economic impact.

Additionally, as a practical matter the timing of multiplier impacts can impact the methodological integrity of an economic base study. Economic base studies are almost always conducted with cross-section data, especially in developing countries. While the location quotient technique and differential estimation of multipliers allow incorporation of time-series data, no such approach has been promoted in the literature on the minimum requirements technique. The problem arises when the observed employment percentages are not representative of a stable state and are merely a single snapshot of a region that is in movement towards equilibrium over time. Pfister (1976) cautions that economic base ratios are susceptible to cyclical factors that could make the regional multiplier unstable over time. This could result in measuring rapidly growing industries with some error, and consequently erratic estimates of the basic-nonbasic ratio. The extent and direction of the measurement error will depend on these industries' relative growth rates and export orientation, as well as regional productive capacity, migration and labor-force participation (Gerking & Isserman, 1981).

Assuming that an NGO can make a valid projection of the regional multiplier, it nonetheless must make the case that the multiplier effect will translate into long-term economic growth. At issue is whether an economy can grow without a strong export base, or if basic employment really is the engine for long-run economic growth. On the one hand, it is obtuse to claim that all growth is due to the export base. After all, as Tiebout (1956, 1962) has observed, the world economy writ large does not export, yet living standards have risen on average. On the other hand, Stabler (1968) does point out "it is the unusual business enterprise that grows without selling external to itself" (p. 14), although this is a facile comparison between a diverse regional economy and a firm—which is a specialized economic unit not meant to encompass a breadth of different industries that would make self-sufficiency possible. Particularly over the long run, there is strong case to be made that export-led growth is ephemeral if not based on a regional comparative (and competitive) advantage. This competitive advantage is a function of its knowledge economy, innovation, and ability to exploit technological advancements that are the underlying drivers of sustainable economic growth. If an export-base cannot provide these necessary advantages for a region, then it represents nothing more than a factory shell that can be quickly abandoned wherever capital and labor are mobile. An NGO projecting regional economic impact must emphasize its link to strategic complementarities and spillovers that encourage a virtuous cycle for regions that can attract the right initial industries. Of course, there is still a strong case to be made that employment is a worthy end in itself as a policy goal even if it does not relate to a grand strategy for regional economic development. There are also pragmatic reasons to avoid loss of employment, such as evidence that job loss leads to increased opioid abuse (Hollingsworth, Ruhm, & Simon, 2017). Therefore, even if there is no clear link between the economic base and long-term economic growth, there is still ample reason to pay attention to its presence in regions, particularly if a large NGO may be considering leaving a community.

2.2 Location Quotient

For an NGO operating in the US or a developed nation, the location quotient (LQ) is the logical choice for projecting indirect economic impact quickly and efficiently. The location quotient and minimum requirements are siblings in the same family of economic-base shortcut techniques, and differ over whether averages or minima are better reference values for the threshold defining where production for domestic consumption ends and for exports begins. The location quotient takes the national average employment level in a given industry as the level of nonbasic employment needed to serve local demand. Any employment exceeding the national average—“excess employment”—is basic employment assumed to be oriented towards exporting to other regions. However, because location quotients reflect the net exports rather than gross exports, they are likely to underestimate regional exports (Hoover, 1975), which would overstate regional multipliers.

The use of location quotients becomes even more problematic in developing nations. In the United States and other developed nations, the location quotient is a highly common short-cut method to estimate regional economic base multipliers. Economic statistics bureaus publish detailed and finely disaggregated employment and economic activity data, which allow location-quotient multipliers to be projected with relatively minimal effort. In most cases in the developing world, the lowest level of data obtainable is unlikely to surpass the two-digit level. This makes the location quotient a highly suspect candidate for projecting multiplier impacts in emerging economies. Since the average economy is likely to be importing as well as exporting some goods at an aggregate industry level, the location technique can underestimate the amount of basic employment and thus overestimate the multiplier without highly disaggregated data.

Apart from the level of disaggregation of the data, the LQ also poses problems in a national economy that is dependent on international trade (Brodsky & Sarfaty, 1977). The location quotient assumes the reference economy is relatively self-sufficient, and therefore uses its average levels as the industry thresholds for determining basic employment. This assumption may reasonably approximate the United States, where net exports are a relatively small portion of the GDP. However, in a developing country where exports are a large percentage of national income, such as Ecuador, this is an unreasonable assumption. If the location quotient technique is used, the reference (average) economy will reflect production that is destined for export as well as internal consumption, and the estimate of basic employment will be biased upwards. Mulligan (2008) finds with two different comprehensive datasets from the US that the location quotient and assignment methods grossly miscalculate the multiplier.

2.3 Minimum Requirements Technique

The minimum requirements approach, like the location quotient method, estimates the levels of basic and non-basic local employment through comparison to a reference economy—the key difference is which economy is used as a reference standard. Whereas the location quotient typically uses the *average* industry levels in the national economy as a reference, the minimum requirements technique uses the *minimum* industry levels of similarly sized regions to determine the level of nonbasic employment.[1] A regional unit with the lowest level of employment within its defined population array is denoted the "minimum shares region" for that industry and plays a key role in measuring the economic base (though it bears mentioning that not all applications of the technique strictly utilize the absolute minimum). The minimum requirements method assumes that the minimum shares region represents the lowest employment level that is needed to satiate local demand for goods and services in that industry. The excess employment in another similarly sized region is therefore reasoned to be for export purposes, and is found by subtracting the observed levels of employment in a given industry in a region from that of the minimum shares region. To calculate the excess employment, a sample of comparable regions or cities must be obtained in order to validly calculate the minimum employment requirement for all industries, and thereby the multiplier.

The core assumption of the minimum requirements technique is that each city within a population group is assumed to have uniform nonbasic industry components. If this assumption is violated, then the minimum shares region is not a valid reference to calculate the excess over nonbasic employment. The minimum requirements method also assumes that most nonbasic industries have negligible barriers to entry; when a regional economic unit reaches the minimum scale needed to sustain an industry it can easily attract it (Brodsky & Sarfaty, 1977). Otherwise, the minimum shares region for a given industry may not be representative of the nonbasic employment for a similarly sized city. Pratt (1968) argues that the minimum requirements method also necessarily implies that cities of a certain size have equal productivity and consumption patterns. If per-capita consumption differs between these cities, the requisite labor force composition to produce internal and export goods would also

[1] Schaffer (1999) demonstrates how the minimum-requirements method relates to the location quotient in the same framework as the latter:

$$LQ_j = \frac{e_j/e}{\min\{E_j/E\}}$$

where $\min\{E_j/E\}$ is the minimum employment share for industry j in similarly sized cities, as opposed to E_j/E, the national average.

unavoidably diverge, thereby invalidating any inference of an "internal-export dichotomy" from the minimum-percentage employment in a particular industry. In other words, the minimum requirements method relies on the supposition that among cities of similar size, the city with the least-percentage employed is meeting its own internal needs, and any excess employment over this percentage in the other cities can be assumed to be for export activity. If these percentages differ because of dissimilar consumption patterns or worker productivity, then this is not a valid supposition. Isserman (1980) conducts a rigorous analysis of the equal-productivity assumption and suggests some ways to correct for its violation, both for location quotients and the minimum requirements technique.

One of the earliest applications of the minimum requirements to developing economies is in Nicaragua, where Brodsky and Sarfaty (1977) analyze data at the municipal government level to estimate the regional multiplier with positive results. More recently, Davies and Davey (2008) utilize the minimum requirements method in Malawi as an adjunct to their social accounting matrix (SAM) model, testing the indirect economic effects of a condition cash transfer (CCT) program. They classified 316 Traditional Authorities (TA) into 16 strata according to population, and regressed the minimum shares in each of the industries on the logarithm of the mean population instead of the median, an atypical choice in the literature due to the skewed nature of city-size distributions. For their region of interest the resulting multiplier was 2.11 based off of an estimated nonbasic ratio of 52.7 percent. The range of multiplier estimates from the SAM model was 2.00 to 2.45, indicating that not only did the minimum requirements method perform successfully as a short-cut method, it also erred on the side of conservatism—a highly desirable property compared to the location quotient method.

As an alternative to the minimum employment value, the second- or third- minimum can serve in its place (Schaffer, 1999). This is exactly what Brodsky and Sarfaty (1977) perform when applying the minimum requirements technique to Nicaragua. They elect to use the third-lowest minimum figure for their estimations, arguing that it is "safer" than using the absolute minimum employment for each industry (pg. 448). Moore and Jacobsen (1984) argue that second minimum values show a closer relationship to population. As an alternative to the second- or third-minimum, Christianson and

Faulkner (1981) utilized the lowest 5% (fifth percentile) of income shares in each sector to calculate local demand. The authors also used incorporated the assumption method into their minimum-requirements analysis, a common practice. They deemed farming, forestry and fisheries, mining, manufacturing, federal civilian and federal military employment as basic sectors and allocated their income in its entirety to export employment.

The most important application of the minimum requirements method in the literature for our purposes comes from Woller and Parsons (2002a and 2002b). Applying the minimum requirements to the Dominican Republic, Woller and Parsons (2002b) project the impact of Project HOPE in the urban areas of Santo Domingo. Interestingly, they test nine different configurations of population classes (see Section 3), and find that changing the groupings can change the estimated impact by as much as $0.67 in indirect economic impact per $1 of local NGO spending. In their study of Project HOPE in Ecuador (Woller & Parsons, 2002a), the authors make a number of very consequential methodological decisions. First, they select the province as their geographic unit, of which Ecuador had 20 in 1999. They immediately eliminate three provinces due to insufficient data. Of the remaining 17 provinces, they exclude any with fewer than 100,000 inhabitants, leaving only 14. Second, they only analyze nine of the 18 ISIC3.0 categories for employment: mining, manufacturing, commerce, hotels & restaurants, financial intermediation, real estate, healthcare & other social services, other community activities, and manufacturing support services. They fit the following equation for the economic base percentage in Ecuador:

$$\hat{s} = -2.44024 + 0.56998 \log_{10} POP \qquad (1)$$

where $\hat{s}$ is the estimated nonbasic employment percentage, and POP is the total population of the region of interest. Section 3 explains the logic of this estimation strategy. The resulting multiplier of 2.87 for a population of 265,499 inhabitants (the population of Imbabura province in 1998) seems to be in line with other multipliers found in developing country contexts and with our own results. Oddly, however, a population size of more than approximately 1,085,731 produces a negative employment multiplier because the estimated nonbasic employment exceeds 100 percent. In fact, their region of interest, Manabí (population: 1,031,927), has a predicted nonbasic employment share of 98.74% under equation (1), resulting in a shockingly high multiplier of 79.5. It appears that the authors estimated (1) at the provincial level and then predicted the nonbasic employment level at the city and/or canton level, as they reported the multiplier for Portoviejo, a city of 180,000 occupants in the province of Manabí. And although they claim to "measure only short-term, point-in-time direct and induced economic impacts", this is misleading. Induced economic impact typically refers to the economic impact captured by the Type II multiplier. The minimum requirements method does not capture the endogenous household induced spending. It can, however, yield a reasonably useful estimate of indirect economic impact.

2.4 Empirical Tests of Economic-Base Multiplier

While the economic-base model may seem comically simplistic, there is also no a priori guarantee that the added complexity of the input-output model will necessarily improve accuracy. Robison and Miller (1991) advocate that economic base multipliers could exceed the accuracy of those derived from input-output models. By contrast, Richardson (1985) ranks economic-base multipliers lower than nonsurvey input-output multipliers in their validity, "which have very little" (p. 608). Then again, if no multiplier models are valid, economic-base multipliers may be least costly of all the worthless ways to estimate the multiplier.

Mulligan (2008) suggests three criteria for assessing the worth of shortcut methods in generating multipliers: 1) the overall value of the multiplier, 2) the multiplier in specific industries, and 3) the distribution of generated multipliers. In this literature review, we only consider comparisons of the estimated multiplier values themselves. As a whole, economic-base multipliers tend to perform well against the more comprehensive I-O and SAM multipliers. Hughes (1997) compares economic-base with input-output multipliers for New Zealand. He found economic-base multipliers resided somewhere in between the Type I (5 percent larger) and Type II (17 percent smaller) input-output multipliers. Davis (1975) compares input-output multipliers to economic base-generated values using a location quotient framework and finds coincidental values. Therefore, there is strong evidence that economic-base multipliers have empirical validity as shortcut methods for estimating regional multipliers.

Among the short-cut methods, Gibson and Worden (1981) find compelling evidence for the superiority of the minimum requirements technique. Testing the census-survey technique against sample-survey, location quotient, and assumption-technique multipliers for a dataset they collected through surveying Arizona communities, they conclude that while the survey method is the superior economic-base technique, the minimum requirements approach is a surprisingly accurate shortcut method, and is largely superior to both location-quotient and assumption-method estimates. Braschler (1972) finds the minimum requirements method performed favorably vis-à-vis a full input-output or social-accounting model, although it overestimated export employment. Christianson and Faulkner (1981) find that on average (across counties), the location quotient generated higher multiplier values than the minimum requirements. They acknowledge that both methods generated low estimates, though they find consistency with other estimates of rural multipliers in the United States through survey methods, such as those of Garrison (1972). When compared with the other shortcut methods in developed-nation contexts, the minimum requirements method has produced relatively comparable results (Brodsky & Sarfaty, 1977; Ullman, Dacey, & Brodsky, 1971). In developing countries, the evidence is overwhelming that minimum requirements technique outperforms other shortcut methods.

3 METHODOLOGY

The minimum requirements method does not have as expansive literature as does the location-quotient method. Nevertheless, there are some core papers from which to construct a methodology. We draw heavily on Woller and Parsons (2002), although we diverge in a couple of key decisions. First, we focus primarily on the canton (equivalent to a county in the US) as our primary unit of analysis instead of the larger province, though we repeat the minimum shares estimation for provinces as well. Second, we include 20 employment categories, excluding only three; Woller and Parsons only analyzed nine categories of employment.

3.1 Theoretical Framework

This section establishes the basis for the nonbasic multiplier. There are k sectors in an economy. For the *j*th sector, express nonbasic employment as E_{NBj}, basic employment as E_{Bj}, and total industry employment as E_{Tj}. Total nonbasic sector is the sum of nonbasic employment in each industry:

$$E_{NB} = \sum_{j=1}^{k} E_{NBj} \tag{2}$$

Likewise, total basic employment is the sum of basic employment over all industries:

$$E_{B} = \sum_{j=1}^{k} E_{Bj} \tag{3}$$

Total employment (basic and nonbasic) is the sum of total basic and total nonbasic employment in each industry for a given region:

$$E_{T} = \sum_{j=1}^{k} E_{Tj} \tag{4}$$

$$= E_B + E_{NB} \tag{5}$$

For each industry *j*, we define the nonbasic ratio as the fraction of total employment that is oriented toward satisfying local demand, and denote it as s_j:

$$s_j = E_{NBj}/E_{Tj} \tag{6}$$

The nonbasic ratio for a given region is the sum of nonbasic employment divided by the total employment:

$$s = \frac{\sum E_{NBj}}{\sum E_{Tj}} \tag{7}$$

$$= E_{NB}/E_T \tag{8}$$

The nonbasic ratio s ($0 < s < 1$) is the aggregate marginal propensity of the region to consume out of local production. For each dollar of exogenous spending in the regional economy, s dollars are re-spent locally, while $1 - s$ dollars are leakage flowing to other regions. Assuming s is stable over time, the total direct and indirect economic impact per dollar is

$$\sum_{t=0}^{\infty} s^t = 1 + s + s^2 + s^3 + \cdots + s^{\infty} \tag{9}$$

where t is simply an index indicating time (or rounds of circulation). If this sequence correctly models the process by which each dollar of exogenous spending circulates in the local economy, then (9) is a power-series expansion that converges to our multiplier, λ:

$$\lambda = \sum_{t=0}^{\infty} s^t = \frac{1}{1 - s} \tag{10}$$

Total employment can be rewritten as a function of just basic employment, scaled by the economic-base multiplier (λ):

$$E_T = \lambda E_B = \frac{1}{1 - s} E_B \tag{11}$$

Since $s = E_{NB}/E_T$, we can express equation (11) as the familiar economic-base multiplier:

$$\lambda = \frac{1}{1 - \frac{E_{NB}}{E_T}} \tag{12}$$

We assume that the average nonbasic percentage is equal to the marginal propensity to consume locally; thus the total (direct and indirect) change in total employment is equal to the product of the multiplier and the exogenous change in basic employment:

$$\delta E_T = \lambda \times \delta E_B \tag{13}$$

We have specified the relationship between the basic, nonbasic and total employment. The next step is to construct an econometric framework to estimate nonbasic employment in each industry j (E_{NBj}), and then sum these nonbasic ratios to find the regional multiplier.

3.2 Econometric Framework

The percentage of nonbasic employment for the *i*th observation (s_i) is estimated as a linear function of the logarithm base-10 of median population ($\tilde{P}_i$), where i indexes the population class. The true model is:

$$s_i = \alpha + \beta \log_{10} \tilde{P}_i + \varepsilon_i \tag{14}$$

Equation (14) is estimated k times, once for each industry $j = 1, \ldots, k$. We can then drop the subscript for observations i, and instead index the fitted equations by j because we will need to sum these by industry in order to arrive at the total nonbasic employment share and then the regional multiplier. We also replace the median population $\tilde{P}$ with POP, the population for the region whose multiplier we are interested in calculating:

$$\hat{s}_j = \hat{\alpha}_j + \hat{\beta}_j \log_{10} POP \tag{15}$$

$\hat{\alpha}_j$ and $\hat{\beta}_j$ are the least-squares estimate of the unknown parameters α and β for the *j*th sector, and $\hat{s}_j$ is the estimate of the percentage of nonbasic employment in the *j*th sector for a region of population size POP. At this point we have a system of k equations:

$$\begin{aligned} \hat{s}_1 &= \hat{\alpha}_1 + \hat{\beta}_1 \log_{10} POP \\ \hat{s}_2 &= \hat{\alpha}_2 + \hat{\beta}_2 \log_{10} POP \\ &\vdots \\ \hat{s}_k &= \hat{\alpha}_k + \hat{\beta}_k \log_{10} POP \end{aligned} \tag{16}$$

In order to arrive at the total nonbasic employment percentage, we must sum these coefficients over the k industries:

$$\frac{E_{NB}}{E_T} = \sum_j \hat{s}_j = \sum_j \left[\hat{\alpha}_j + \hat{\beta}_j(\log_{10} POP)\right] \tag{17}$$

$$= \sum_j \hat{\alpha}_j + \log_{10} POP \sum_j \hat{\beta}_j \tag{18}$$

Denoting the regional nonbasic employment percentage $\frac{E_{NB}}{E_T}$ as s, and the summed fitted coefficients $\sum \hat{\alpha}_j$ and $\sum \hat{\beta}_j$ as a and b, respectively, we can rewrite (18) more simply:

$$s = a + b \log_{10} POP \tag{19}$$

Finally, since $\lambda = \frac{1}{1-s}$, we can calculate the regional multiplier (λ):

$$\lambda = \frac{1}{1 - (a + b \log_{10} POP)} \tag{20}$$

3.3 Steps

Census or survey data reporting employment levels must undergo several steps to implement the minimum requirements method. We illustrate these steps using a simplified version of our data consisting of a limited number of regions and only two industries.

STEP 1

Employment and population data are obtained for each regional unit. Some authors eliminate regions if they have insufficient data, and may omit specific industries such as agriculture or mining. Any raw employment levels must be converted to percentages of total regional employment by this step. This is to standardize the employment data; otherwise, the least-populated regions are likely to have their industries be counted as the minimum employment shares, and nonbasic percentages will be biased downward.

Obs.	Region	Population	Employment (#)		Employment (%)	
			Industry 1	*Industry 2*	*Industry 1*	*Industry 2*
1	Pastaza	83,478	9,153	21,760	0.27	0.65
2	Napo	102,861	15,841	20,905	0.38	0.51
3	Orellana	134,689	19,203	26,915	0.36	0.51
4	Carchi	164,162	24,787	36,644	0.36	0.53
5	Bolivar	183,742	38,136	26,754	0.52	0.37
6	Imbabura	397,199	32,850	117,474	0.19	0.70
7	Cotopaxi	407,713	74,722	85,666	0.43	0.49
8	Loja	450,342	53,454	106,378	0.30	0.60
9	Chimborazo	458,560	83,281	102,491	0.42	0.51
10	Tungurahua	502,921	66,005	165,200	0.27	0.67
11	Esmeraldas	533,055	58,503	98,551	0.29	0.48
12	El Oro	597,991	61,479	165,431	0.24	0.65
13	Manabí	1,400,000	138,132	278,360	0.28	0.56
14	Pichincha	2,600,000	83,803	1,058,174	0.07	0.84
15	Guayas	3,600,000	180,248	1,098,625	0.12	0.73

STEP 2

Population groups must be defined, and decisions must be made as to the number of different population groups and their population size cutoffs. The upper and lower bounds for each group should be selected on the basis of where regional characteristics emerge. As far as how many to define, that number has ranged anywhere from five to twenty in previous studies. We break down both of these decisions below, but it is safe to say that a lot of discretion is exercised at this step. Each region is assigned to a class using this classification:

Obs.	Region	Population	Industry 1	Industry 2	Class
1	Pastaza	83,478	0.27	0.37	1
2	Napo	102,861	0.38	0.53	1
3	Orellana	134,689	0.36	0.49	1
4	Carchi	164,162	0.36	0.51	2
5	Bolivar	183,742	0.52	0.65	2
6	Imbabura	397,199	0.19	0.48	2
7	Cotopaxi	407,713	0.43	0.73	3
8	Loja	450,342	0.30	0.70	3
9	Chimborazo	458,560	0.42	0.60	3
10	Tungurahua	502,921	0.27	0.56	4
11	Esmeraldas	533,055	0.29	0.51	4
12	El Oro	597,991	0.24	0.65	4
13	Manabi	1,400,000	0.28	0.84	5
14	Pichincha	2,600,000	0.07	0.67	5
15	Guayas	3,600,000	0.12	0.51	5

🡐

Bin	Class
0 - 149,999	1
150,000 - 399,999	2
400,000 - 499,999	3
500,000 - 999,999	4
1,000,000+	5

STEP 3

The minimum employment share for each industry is selected within each population group. Moreover, the median population is found for each population group, and with these outputs the dataset is transformed into summary statistics using the Stata command *collapse* by population class.

Obs.	Region	Population	Industry 1	Industry 2	Class
1	Pastaza	83,478	0.27	0.37	1
2	Napo	102,861	0.38	0.53	1
3	Orellana	134,689	0.36	0.49	1
4	Carchi	164,162	0.36	0.51	2
5	Bolivar	183,742	0.52	0.65	2
6	Imbabura	397,199	0.19	0.48	2
7	Cotopaxi	407,713	0.43	0.73	3
8	Loja	450,342	0.30	0.70	3
9	Chimborazo	458,560	0.42	0.60	3
10	Tungurahua	502,921	0.27	0.56	4
11	Esmeraldas	533,055	0.29	0.51	4
12	El Oro	597,991	0.24	0.65	4
13	Manabí	1,400,000	0.28	0.84	5
14	Pichincha	2,600,000	0.07	0.67	5
15	Guayas	3,600,000	0.12	0.51	5

Median value
Minimum value

After collapsing, the data show only the population class i in n rows, the ith median population, and the minimum employment percentage for industry j in population class i. A new variable is created and calculated as the logarithm base-10 of the median population for each class. This will serve as the independent variable in our regressions.

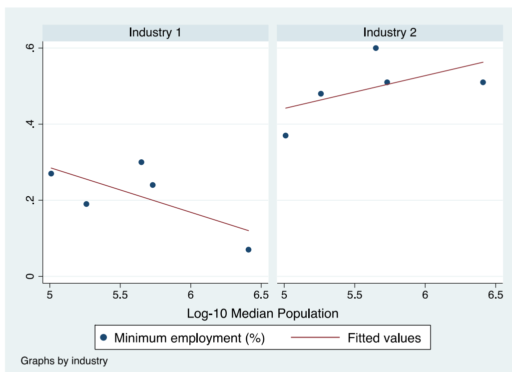
Class	Median Pop. ($\widetilde{P}_i$)	$\log_{10} \widetilde{P}_i$	Min. 1	Min. 2
1	102,861	5.01	0.27	0.37
2	183,742	5.26	0.19	0.48
3	450,342	5.65	0.30	0.60
4	533,055	5.73	0.24	0.51
5	2,600,000	6.41	0.07	0.51

We take the step of reshaping the data in order to facilitate regression for each industry quickly using the Stata command *statsby*:

Class	Industry	$\log_{10}\tilde{P}$	Min. Emp.
1	1	5.01	0.27
2	1	5.26	0.19
3	1	5.65	0.3
4	1	5.73	0.24
5	1	6.41	0.07
1	2	5.01	0.37
2	2	5.26	0.48
3	2	5.65	0.60
4	2	5.73	0.51
5	2	6.41	0.51

STEP 4

The minimum employment parameters $\hat{\alpha}$ and $\hat{\beta}$ are estimated across the population groups for each industry *j* separately using ordinary least squares (OLS). Running separate regressions for each industry *j* has the effect of smoothing outliers (Gibson & Worden, 1981).



STEP 5

The fitted coefficients are then summed over *j* (=*1, ... , k*) to obtain the overall coefficients for the minimum requirements equation, $\sum_j \hat{\alpha}_j$ and $\sum_j \hat{\beta}_j$, which we will denote *a* and *b*, respectively.

Industry	$\hat{\alpha}$	$\hat{\beta}$
1	0.8737	-0.1176
2	0.0096	0.0863
Total	**0.8834**	**-0.0313**
	(*a*)	(*b*)

STEP 6

In our example, the regression yields a fitted equation of $\hat{s} = 0.8834 + -0.0313 \log POP$. We can return to the original data sheet and calculate the estimated nonbasic employment percentage for each region and its economic-base multiplier.

Obs.	Region	Population	E_{NB}/E_T	Multiplier
1	Pastaza	83,478	73.0%	3.70
2	Napo	102,861	72.7%	3.66
3	Orellana	134,689	72.3%	3.61
…	…	…	…	…
15	Guayas	3,600,000	67.8%	3.11

The NGO may now forecast the direct and indirect economic impact of an exogenous increase in basic employment or spending.

3.4 Data

Data were gleaned from several different Ecuadorian sources, but principally from the National Census of Population and Housing (*Censo Nacional de Población y Vivienda*) of 2010, the latest census to be conducted in Ecuador (the next census is in 2020). Census data is the only data resource in Ecuador for regional employment; surveys from inter-census years only report on national employment and certain large cities.

3.4.1 *Industry Employment*

Employment is classified according the International Standard Industrial Classification (ISIC) Version 4.0, which is the international analogue to the North American Industry Classification System (NAICS). The ISIC4.0 classification comprises 23 industries, shown below in Table 1. We included all industries in our analysis but for three: new workers, undeclared workers, and activities of extraterritorial organizations and bodies.

Table 1. ISIC 4.0 categories

Category	Description	Included?
A	Agriculture, forestry and fishing	▯
B	Mining and quarrying	▯
C	Manufacturing industries	▯
D	Electricity, gas, steam and air conditioning supply	▯
E	Water supply; sewerage, waste management and remediation	▯
F	Construction	▯
G	Wholesale and retail trade	▯
H	Transportation and storage	▯
I	Accommodation and food service activities	▯
J	Information and communication	▯
K	Financial and insurance activities	▯
L	Real estate activities	▯
M	Professional, scientific and technical activities	▯
N	Administrative and support service activities	▯
O	Public administration and defense	▯
P	Education	▯
Q	Human health activities	▯
R	Arts, entertainment and recreation	▯
S	Other service activities	▯
T	Activities of households as employers	▯
U	Activities of extraterritorial organizations and bodies	NO
V	Undeclared	NO
W	New worker	NO

The level of industry classification will affect forecasted impact outcomes. In contrast to the LQ method, where more disaggregated economic sector data is better, the minimum requirements technique is optimally used with more aggregated employment and income data (Brodsky & Sarfaty, 1977). If we disaggregate into too granular of a level of detail, we may confront regions with zero percent employment in many industries, causing all production to be for export and the minimum requirements multiplier to be overly conservative (Pratt, 1968). At higher levels of aggregation, the data will contain a diversity of different occupations within an industry, and artificially low minimum shares observations are less likely. Disaggregation of industries therefore tends to have undesirable effects on the minimum requirements method, so we keep it at the 1-digit level.

Many authors eliminate agricultural industry data from their estimations. Woller and Parsons (2002a) eliminate agriculture from their analysis of minimum employment requirements in Ecuador because of insufficient data. Brodsky and Sarfaty (1977) do not find a positive relationship, as they had for all other industries, between municipal size and minimum employment percentage in the agricultural or mining sectors. Moore, in two separate analyses (1975, 1980) singles out agriculture and construction as being poor fits for the model, which he attributes to the "specialized resource base necessary for the extractive industries", as well as the fact that regional location and resource endowment may be much more indicative of basic employment than just community size. While the arguments are convincing, this decision may have negative consequences for use of the minimum requirements technique to assess the community impact in regions that are highly dependent on agriculture. Consequently, we do not eliminate these industries.

3.4.2 *Regions*

One of the most important decisions in the minimum requirements methodology is the unit of analysis. Roterus and Calef (1955) have noted that the economic-base framework depends crucially on the regional unit, and that "any data … may change, chameleon-like, if the area is delimited differently" (p. 17). One noteworthy decision taken by Woller and Parson (2002a) is to analyze entire provinces instead of cantons, cities or parishes. They also exclude any regions with fewer than 100,000 inhabitants, and group the remaining provinces into nine population groups.

In contrast to Woller and Parsons, we focus on the canton (*cantón*) rather than the smaller parish (*parroquia*) or larger province (*provincia*). Two main reasons motivate this decision. First, data on cantons is easily obtained from the Ecuadorian statistical agency (*Instituto Nacional Estadistica y Censal*), and so there is little a priori reason to rejecting a smaller economic base unit in favor one that is larger. Cantons can be considered self-sufficient economic units, though obviously the degree will vary based on size (which makes the classification important; see below). Parishes, on the other hand, are probably too small to be analyzed as a self-sufficient economic unit; therefore using this level of analysis may underestimate the minimum requirements percentage in many industries. Additionally, as a practical matter the parish level the data does begin to exhibit missing values for certain industries; this could either be due to zero values for these areas (which are typically rural parishes where zero percent employment in manufacturing, for example, is entirely plausible) or due to the constraints of data collection in these areas (which again, in rural areas is completely plausible, particularly in the isolated Ecuadorian Amazon or Andes). If canton-level data are utilized we can skirt the issue of confronting missing data. Second, this unit level allows us to focus in on our target area and maximize the relevance of the multiplier estimate. Even though our main focus is on the canton, we also conduct our analysis on the provincial level. We do not include every region in our analysis, however. We eliminate unincorporated territory and the Galapagos Islands across all our models because these regions are unlikely to have employment patterns that reflect self-sufficiency and nonbasic employment due to their geographic peculiarities.

3.4.3 *Population Classes*

Even more important for the minimum requirements method is how to divide up the overall sample of regions into different population strata. Consumption and employment patterns should be similar within a given population class. The cutoffs ought to correspond to the thresholds above or below which there are expected differences in minimum shares that are indicative of nonbasic employment. More precisely, there has to be a resemblance between the level of (unobserved) minimum employment, and the expected marginal change in overall consumption (or employment) with respect to an exogenous change in investment demand.

Although the cutoffs are an important part, they are only part of the problem. The number of population classes to be analyzed must be determined—a matter of great importance, if only because the number of population classes formed determines the number of observations (and hence the degrees of freedom) in the regressions. There is no formal or established method to construct the population classes. If central place theory and economic base theory are essentially equivalent, as Nourse (1978) and Horn and Prescott (1978) argue, then it may be useful to borrow concepts from central place theory to generate the clusters. After all, central place theory is predicated on the hierarchy of cities across space, and each level of the hierarchy has a level of population that should also affect the percentage of the labor force that services local consumption. The central place hierarchy suggests that there may be seven levels (for a k=7 arrangement) in the spatial hierarchy. Although this seems helpful for choosing the number of groups, it is completely silent on the question of what population to use as the respective cutoffs. One straightforward way would be to plot a log-chart and divide the rank-size hierarchy into seven equal groups. While this is relatively straightforward, it is essentially arbitrary. The choice of cutoffs should be based on some theoretical reasoning about the nature of cities as a function of population. In the end, we merely make use of knowledge of local conditions based on years of living in Ecuador to construct our classification.

Table 2. Regional classification for cantons and provinces

Canton		Province	
Population	Frequency	Population	Frequency
0 - 2,999	3	0 - 99,999	4
3,000 - 9,999	46	100,000 - 149,999	3
10,000 - 24,999	64	150,000 - 249,999	4
25,000 - 49,999	50	250,000 - 449,999	4
50,000 - 99,999	33	450,000 - 599,999	5
100,000 - 149,999	5	600,000 - 999,999	2
150,000 - 249,999	11	1,000,000+	4
250,000 - 399,999	3		
400,000 - 599,999	1		
600,000+	2		

No correction in our dataset is made to combine cities from separate parishes even if they are suburbs or part of the urban periphery of another canton. Previous authors have made these corrections; for instance Ullman and Dacey (1960) only consider “independent cities” owing to suburbs having a “different structure”. For time and practicality we do not attempt to make any such correction to the groupings, and therefore cantons such as Durán, which is largely considered an exurb of Guayaquil, appear as a separate regional unit in our dataset.

4 RESULTS

4.1 Minimum Requirements 2010

4.1.1 *Canton*

Regressing the minimum employment share across population classes in each of the 20 industries, we arrive at the results in in Table 3.

Table 3. Minimum requirements shares for cantons

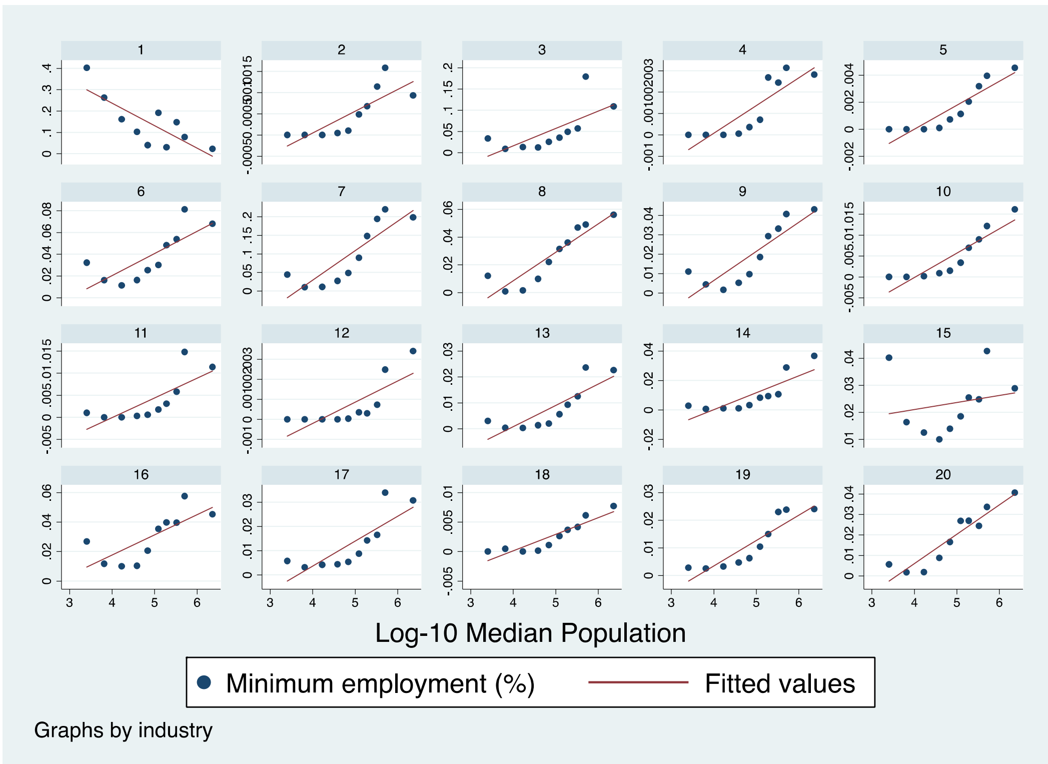
Industry	$\hat{\alpha}$	$\hat{\beta}$	R^2
1	0.6569315 (0.1404353)	-0.1051208 (0.0283405)	0.63
2	-0.0020083 (0.000642)	0.0005131 (0.0001296)	0.66
3	-0.1479442 (0.0750335)	0.0410061 (0.0151421)	0.48
4	-0.0050999 (0.0013568)	0.0012946 (0.0002738)	0.74
5	-0.0070848 (0.0014145)	0.0017721 (0.0002854)	0.83
6	-0.0608631 (0.0290002)	0.0203144 (0.0058524)	0.60
7	-0.2888828 (0.0821862)	0.0794965 (0.0165855)	0.74
8	-0.0737239 (0.0160066)	0.0205596 (0.0032302)	0.84
9	-0.0533127 (0.0152985)	0.0149494 (0.0030873)	0.75
10	-0.0233875 (0.0046601)	0.0058178 (0.0009404)	0.83
11	-0.0179216 (0.0064773)	0.0044634 (0.0013071)	0.59
12	-0.0044386 (0.0014507)	0.0010594 (0.0002928)	0.62
13	-0.0320548 (0.0094433)	0.0082192 (0.0019057)	0.70
14	-0.0457958 (0.0136731)	0.0114881 (0.0027593)	0.68
15	0.0107091 (0.0215308)	0.0025845 (0.004345)	0.04
16	-0.0370142 (0.021106)	0.0136691 (0.0042593)	0.56
17	-0.0374727 (0.0124375)	0.0102802 (0.0025099)	0.68
18	-0.0110875 (0.0021477)	0.0028051 (0.0004334)	0.84
19	-0.0332841 (0.00749)	0.0091889 (0.0015115)	0.82
20	-0.0512696 (0.0094588)	0.0143348 (0.0019088)	0.88
Total	-0.2650055	0.1586955	

The summed regression coefficients give us a fitted line of

$$\hat{s} = -0.2650055 + 0.1586955\log(POP) \tag{21}$$

Each of the fitted lines used to arrive at this equation are displayed in Figure 1.

Figure 1. Fitted equations by industry, canton-level minimum requirements method.



For the canton of Ibarra, with a population of 180,845 inhabitants, (21) yields a nonbasic employment percentage of 56.9 percent, and a multiplier of 2.32. Figure 2 displays a histogram of the multipliers and a fitted kernel density function (KDF).

Most multipliers are clustered between 1.5 and 2.5, although the cantons with the largest cities (Quito and Guayaquil) have large multipliers, approaching 4. The results indicate that larger regions have larger multipliers, consistent with the theory that larger regions are more self-sufficient, and each dollar of exogenous spending will go farther within that regional system. We can plot the multiplier values against the logarithm of population to show this relationship, as in Figure 3. Clearly increasing population is associated with increasing nonbasic ratios, and hence multipliers are higher.

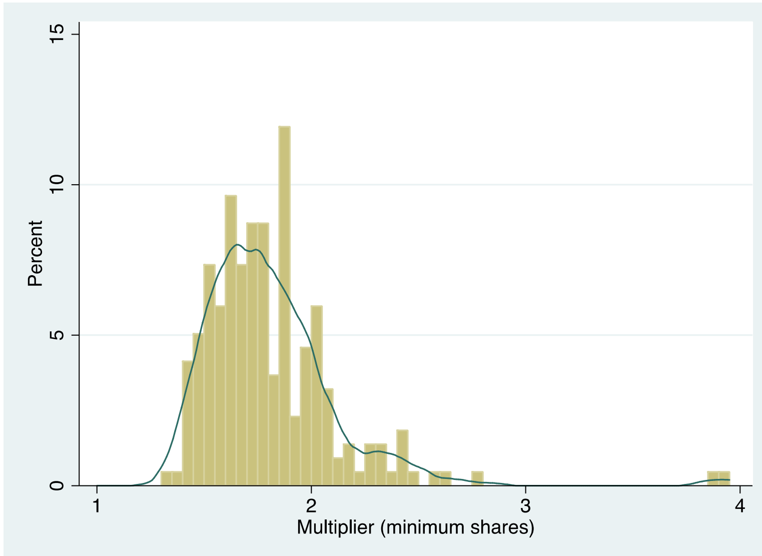


Figure 2. Histogram of multiplier estimates, canton-level minimum requirements method.

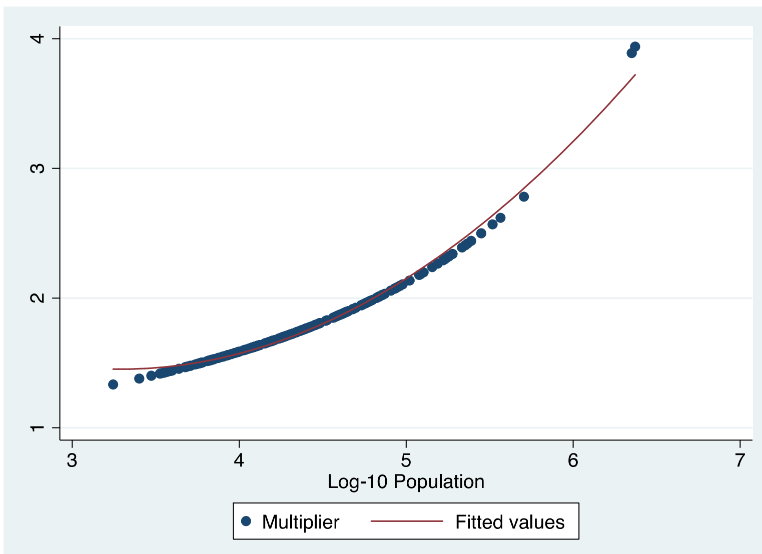


Figure 3. Scatterplot and fitted line of multiplier estimates, canton

5th Percentile

Following Christianson and Faulkner (1981), we also calculate the nonbasic ratios using the lowest 5% of employment in each population class. The econometric specification and methodology is exactly the same as before, but the 5th-percentile employment percentage is assigned to each population class instead of the minimum share. On average, we would expect to see higher nonbasic ratios, and hence multipliers using this method, since it assigns a more employment to nonbasic sectors. The regression outputs are given below.

Table 4. Fitted coefficients for the 5th-percentile minimum requirements, canton level.

Industry	$\hat{\alpha}$	$\hat{\beta}$	R^2
1	0.7905573 (0.1209419)	-0.1274539 (0.0244066)	0.77
2	-0.0014591 (0.0006383)	0.0004201 (0.0001288)	0.57
3	-0.1396752 (0.0731691)	0.0397302 (0.0147658)	0.48
4	-0.0048855 (0.001291)	0.0012608 (0.0002605)	0.75
5	-0.0068092 (0.0012882)	0.001731 (0.00026)	0.85
6	-0.0527708 (0.0273817)	0.0189488 (0.0055258)	0.60
7	-0.2580614 (0.069908)	0.0746376 (0.0141077)	0.78
8	-0.0613842 (0.0113161)	0.0185634 (0.0022836)	0.89
9	-0.048407 (0.0130336)	0.0141746 (0.0026302)	0.78
10	-0.0222364 (0.0044464)	0.0056308 (0.0008973)	0.83
11	-0.0176782 (0.0063787)	0.0044292 (0.0012873)	0.60
12	-0.0044365 (0.0014476)	0.0010593 (0.0002921)	0.62
13	-0.0310961 (0.0091424)	0.0080697 (0.001845)	0.71
14	-0.0443916 (0.0134626)	0.0112608 (0.0027168)	0.68
15	0.0194486 (0.0206274)	0.0010525 (0.0041627)	0.01
16	-0.0204644 (0.0162465)	0.0109093 (0.0032786)	0.58
17	-0.0358622 (0.0119341)	0.0100367 (0.0024084)	0.68
18	-0.0104147 (0.0018459)	0.0027007 (0.0003725)	0.87
19	-0.0321938 (0.0069893)	0.009025 (0.0014105)	0.84
20	-0.0434212 (0.0066333)	0.0130283 (0.0013386)	0.92
Total	**-0.0256416**	**0.1192149**	

Each panel of Figure 4 shows a scatterplot with the fitted line for each industry from Table 4.

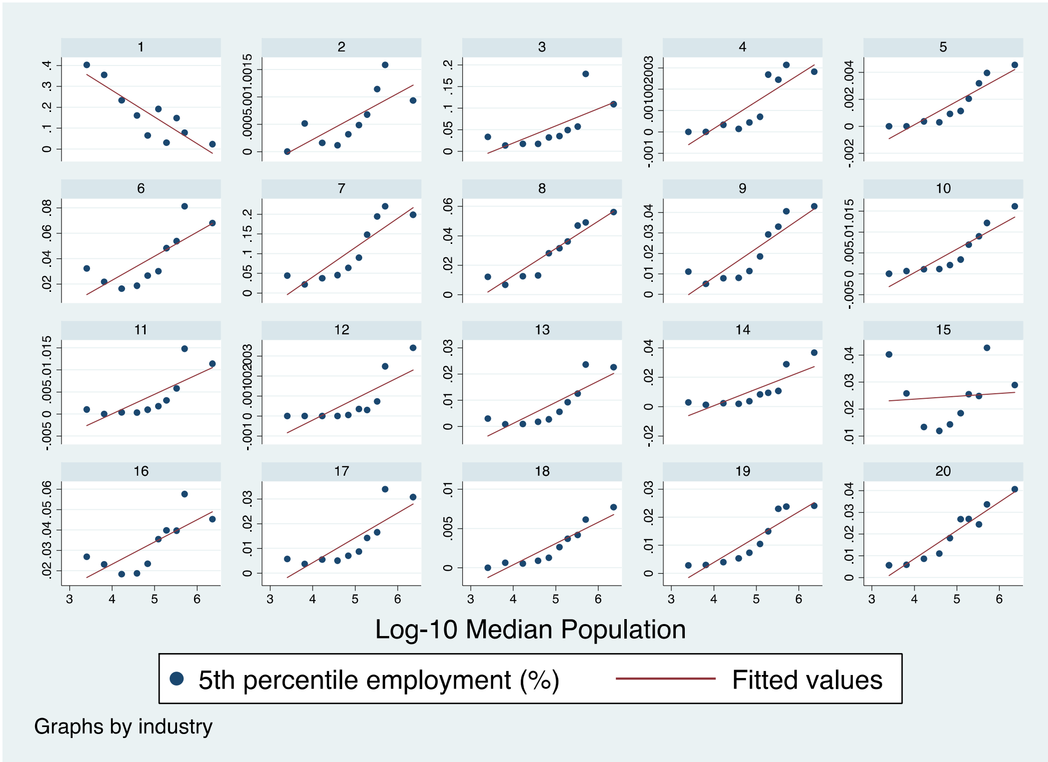


Figure 4. Fitted equations by industry, canton-level 5th-percentile minimum requirements

Taken together, the fitted coefficients return the following equation to predict the nonbasic ratio for a given region:

$$\hat{s} = -0.0256416 + 0.1192149 \log(POP) \tag{22}$$

As hypothesized, the multiplier estimates tend to be higher on average, as Figure 5 illustrates. Because the 5th percentile employment percentage is higher than the minimum value in each population class, the regression will predict a higher nonbasic employment level, resulting in higher multipliers.

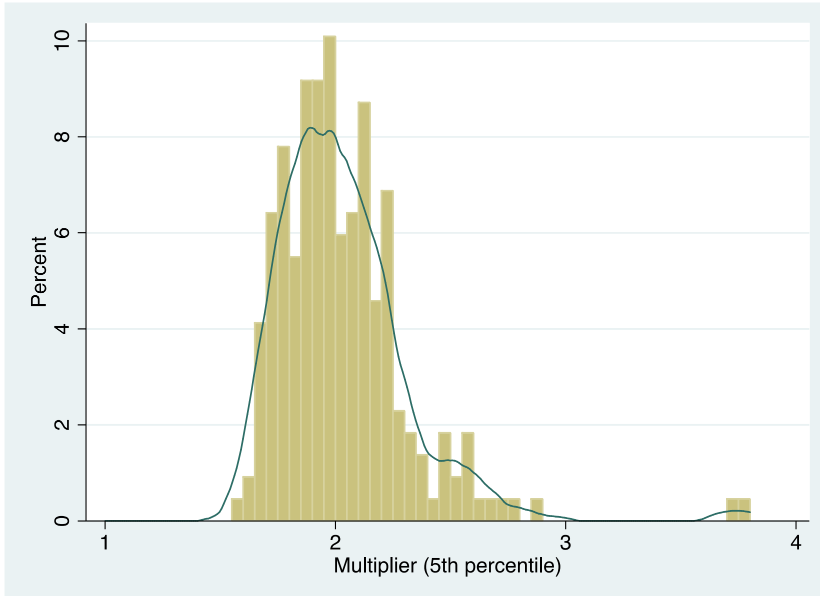


Figure 5. Histogram of multiplier estimates, canton-level 5th-percentile minimum requirements

Summary statistics for the multipliers generated also illustrate this point. Both the mean (1.81) and median (1.76) multipliers are lower using the minimum share rather than the 5th percentile (2.03 and 1.99, respectively). Interestingly, the maximum value for the multiplier is lower using the 5th-percentile share. Overall, the minimum employment share is preferable if the goal is to err on the side of a conservative multiplier estimate.

Table 5. Summary statistics for the minimum requirements multipliers

Method	Mean	SD	Median	Min	Max	Skewness	Kurtosis
Minimum	1.81	0.328	1.76	1.33	3.94	2.81	17.21
5th percentile	2.03	0.292	1.99	1.57	3.76	2.21	12.49

4.1.2 *Province*

While this paper prefers the canton level, we also conduct the same analysis for the provincial level.

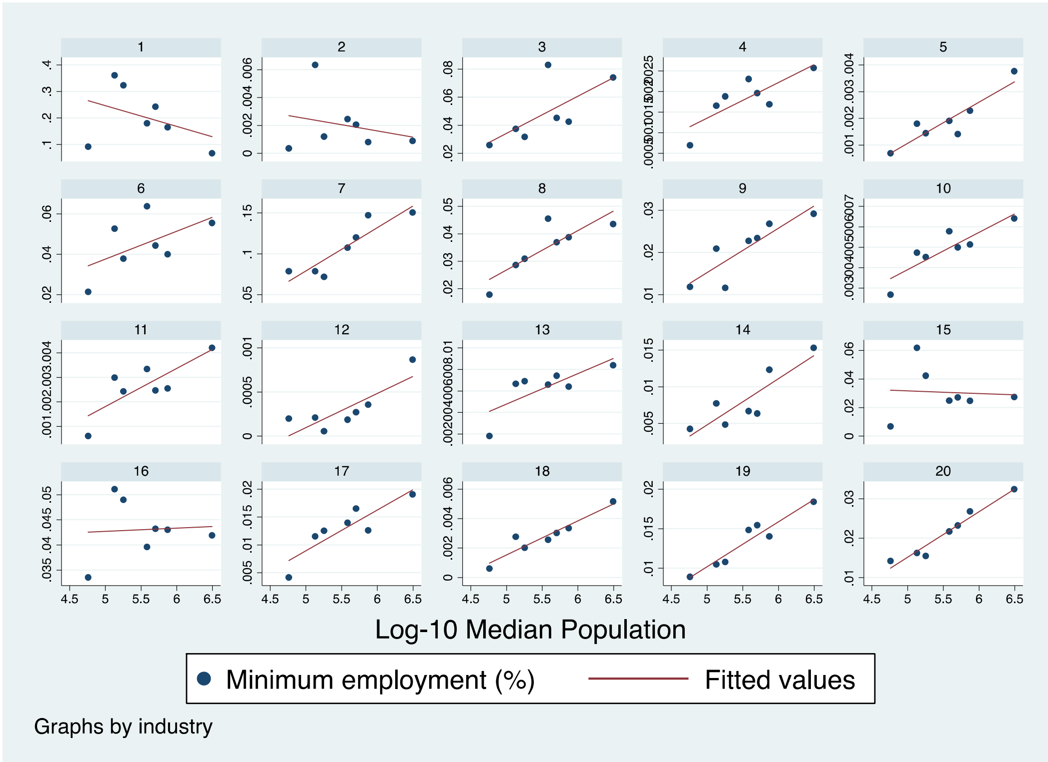


Figure 6. Fitted equations for minimum requirements at the province level

Summing the fitted coefficients across these 20 industries as before, we arrive at the following equation for provincial nonbasic share:

$$\hat{s} = 0.1704973 + 0.0798541 \log(POP) \tag{23}$$

Equation (23) predicts that an NGO operating in the Imbabura province (population: 397,199) will generate $1.62 of indirect economic activity for every $1 of local expenditure. In contrast, our canton-level model predicts that local spending in the Ibarra canton (the largest of the Imbabura province) will generate $1.32 of indirect impact. The distribution of multipliers is displayed in Figure 7 The average multiplier at the provincial level is higher than cantonal multipliers, which is to be expected for a regional unit that is more self-sufficient and therefore has higher nonbasic employment. Estimating multipliers at the province does little to change the multipliers for the largest cities of Quito and Guayaquil, which have multipliers of about 4. In general, the multipliers at the canton level seem just as plausible and tractable as those at the provincial level.

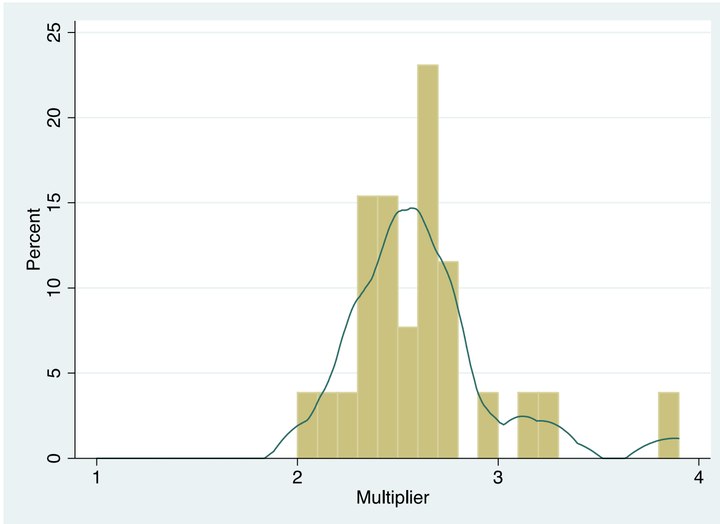


Figure 7. Histogram of the estimated multipliers, province.

4.2 Location Quotient 2010

For comparison, we also calculated multipliers using the location quotient. Consistent with our predictions, the location quotient method generated implausibly high multipliers. The average LQ multiplier was 4.30, more than double the average multiplier using the minimum requirements method. The range is extraordinary; the highest LQ multiplier reaches 20.78. Table 6 gives a side-by-side comparison of the LQ and MR multipliers for the main city in each province.

The comparison is striking, with the LQ method clearly inflating the regional multipliers to bizarre levels. Calculating the location quotient at the provincial level does not improve the comparison. The mean multiplier is even higher (7.19), although the highest multiplier slightly less laughable (20.07).

Table 6. Location quotient and minimum requirements multipliers, canton

Canton, Province	Population	LQ		MR(1)		MR(2)	
		NB	Multiplier	NB	Multiplier	NB	Multiplier
San Cristobal, Galápagos	7,165	73.0%	3.70	34.7%	1.53	43.4%	1.77
Zamora, Zamora Chinchipe	25,177	76.8%	4.32	43.3%	1.76	49.9%	2.00
Morona, Morona Santiago	40,975	81.8%	5.51	46.7%	1.88	52.4%	2.10
Tena, Napo	60,495	77.1%	4.37	49.4%	1.98	54.4%	2.19
Pastaza, Pastaza	61,845	83.8%	6.17	49.5%	1.98	54.6%	2.20
Azogues, Cañar	69,948	88.0%	8.31	50.4%	2.02	55.2%	2.23
Orellana, Orellana	72,105	88.1%	8.38	50.6%	2.02	55.4%	2.24
Tulcan, Carchi	86,710	89.3%	9.34	51.9%	2.08	56.3%	2.29
Guaranda, Bolívar	91,767	69.0%	3.22	52.3%	2.09	56.6%	2.30
Lago Agrio, Sucumbíos	91,847	91.7%	12.02	52.3%	2.09	56.6%	2.30
Santa Elena, Santa Elena	143,310	90.1%	10.13	55.3%	2.24	58.9%	2.43
Babahoyo, Los Rios	154,675	85.6%	6.93	55.9%	2.27	59.3%	2.46
Latacunga, Cotopaxi	170,192	87.2%	7.83	56.5%	2.30	59.8%	2.49
Ibarra, Imbabura	180,845	88.7%	8.83	56.9%	2.32	60.1%	2.51
Esmeraldas, Esmeraldas	189,834	93.6%	15.65	57.3%	2.34	60.4%	2.52
Loja, Loja	216,118	84.6%	6.50	58.2%	2.39	61.0%	2.57
Riobamba, Chimborazo	226,769	90.4%	10.47	58.5%	2.41	61.3%	2.58
Machala, El Oro	245,128	87.7%	8.12	59.0%	2.44	61.7%	2.61
Portoviejo, Manabí	281,747	91.5%	11.82	60.0%	2.50	62.4%	2.66
Ambato, Tungurahua	329,296	85.4%	6.85	61.1%	2.57	63.2%	2.72
Santo Domingo, SD	367,323	92.1%	12.69	61.8%	2.62	63.8%	2.76
Cuenca, Azuay	507,687	81.0%	5.25	64.0%	2.78	65.5%	2.89
Quito, Pichincha	2,200,000	79.8%	4.95	74.2%	3.87	73.0%	3.71
Guayaquil, Guayas	2,400,000	83.5%	6.05	74.8%	3.96	73.5%	3.77

Min(1): Minimum requirements using the minimum share of employment

Min(2): Minimum requirements using the 5th percentile employment

For the province of Santa Elena, the location quotient projects that every $1 of exogenous increase in basic employment creates $19.07 of economic activity—an extraordinary prediction. The minimum requirements technique projects only $1.56 of indirect economic impact for that same region. The location quotient for an NGO in Imbabura is slightly less extreme, but still high (13.21) compared to the minimum requirements multiplier (2.62). The location quotient is clearly inappropriate for developing country contexts and underperforms against the minimum requirements technique.

Table 7. Location quotient and minimum requirements multipliers, province

Province	Population	LQ		MR	
		NB	Multiplier	NB	Multiplier
Azuay	710,766	88.4%	8.59	63.8%	2.76
Bolívar	183,742	64.4%	2.81	59.1%	2.44
Cañar	224,433	80.2%	5.05	59.8%	2.49
Carchi	164,162	80.5%	5.13	58.7%	2.42
Cotopaxi	407,713	76.4%	4.24	61.9%	2.62
Chimborazo	458,560	76.8%	4.31	62.3%	2.65
El Oro	597,991	90.8%	10.92	63.2%	2.72
Esmeraldas	533,055	89.4%	9.39	62.8%	2.69
Guayas	3,600,000	92.0%	12.47	69.4%	3.27
Imbabura	397,199	92.4%	13.21	61.8%	2.62
Loja	450,342	83.3%	6.00	62.2%	2.65
Los Rios	778,135	76.5%	4.25	64.1%	2.78
Manabí	1,400,000	91.0%	11.09	66.1%	2.95
Morona Santiago	147,655	70.0%	3.33	58.3%	2.40
Napo	102,861	74.4%	3.91	57.1%	2.33
Pastaza	83,478	80.2%	5.06	56.4%	2.29
Pichincha	2,600,000	83.5%	6.07	68.3%	3.15
Tungurahua	502,921	84.4%	6.41	62.6%	2.67
Zamora Chinchipe	90,407	69.1%	3.24	56.6%	2.31
Galápagos	23,630	75.1%	4.01	52.0%	2.08
Sucumbíos	174,481	82.9%	5.83	58.9%	2.43
Orellana	134,689	77.4%	4.42	58.0%	2.38
Santo Domingo	367,323	92.1%	12.69	61.5%	2.60
Santa Elena	306,538	95.0%	20.07	60.9%	2.56

5 SUMMARY AND CONCLUDING REMARKS

We test three different methods (minimum requirements, minimum requirements with the 5th percentile employment share, and location quotients) for projecting the impact of an NGO in the Ibarra, Imbabura region of Ecuador. Of the three methods, we can easily discard the location quotient, which produces multipliers that are bizarrely large. The multiple requirements method shows stronger results. The decision of whether to use the minimum shares or the 5th percentile employment percentage in each population class is not so clear-cut. If an NGO prefers a conservative multiplier estimate, it should opt to use the minimum share. Overall, the minimum requirements method is a robust and low-cost shortcut method for an NGO to project its indirect economic impact in a region. Our estimates indicate that each dollar spent in the Imbabura region resulted in between $1.32 and $1.62 of indirect economic impact in that region.

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