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Expenditure needs estimation for Argentinian provinces: A structural modeling approach

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"Estimación de las necesidades de gasto para las provincias argentinas: un enfoque de modelización estructural"

Resumen

Argentina ha estado incumpliendo su Constitución desde 1994 al no aprobar una ley que determine completamente las transferencias fiscales intergubernamentales nacionales. Este trabajo utiliza un marco estructural innovador para estimar y finalmente proponer un nuevo esquema de distribución para tales transferencias. El enfoque estructural permite recuperar los parámetros profundos para estimar adecuadamente las necesidades de gasto de cada provincia y utilizarlas para establecer las tasas de distribución que deben asignarse a cada jurisdicción.

Palabras clave: Necesidades de Gasto, Enfoque Estructural, Esquema de Distribución, Transferencias Fiscales

Códigos JEL: H71 - H72 - H77

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Abstract
Argentina has been reneging on its Constitution since 1994 by not passing a law that fully determines national intergovernmental fiscal transfers. This paper uses an innovative structural framework to estimate and ultimately propose a new distribution scheme for such transfers. The structural approach allows to recover the deep parameters to properly estimate each province's expenditure needs and use them to establish the distribution rates that should be assigned to each jurisdiction.

Keywords: Expenditure Needs, Structural Approach, Distribution Scheme, Fiscal Transfers

JEL Classification: H71 - H72 - H77

1. Introduction

The main goal of this paper is to analyze the current fiscal transfer system in Argentina using a structural modeling approach for estimating measures of expenditure needs. By doing so, I propose a different method to distribute the national intergovernmental fiscal transfers than the actual equalization scheme.

The analysis will focus primarily on the estimation of the expenditure needs for the Argentinian provinces. The expenditure needs will be recovered using a structural modeling approach proposed by Langørgen (2015). As for the fiscal capacity part of the fiscal equation, I will determine the national intergovernmental fiscal transfers based on the actual regional income raised.

One of the main contributions of this paper is to calculate the amount in Argentinian pesos that every jurisdiction needs to be compensated for in order to properly offer its own bundle of basic services to the population. Even more so, reaching a level of detail by separating

between fix and variable costs never done for Argentina.

The current fiscal transfer scheme in Argentina is called federal coparticipation of taxes. The main purpose is to distribute part of the income raised by the federal state. Even though this system was stablished by the Constitution in 1994, it does not exist a proper law that fully determines how it should work.

The coparticipation system in Argentina dates back to 1935 with several modifications through its history. The last one was in 1994 when the new National Constitution recognized the importance of the fiscal transfer scheme and dictated a period of two years for the coparticipation regime and the regulation of the federal fiscal body to be properly established by a new law. However, the sanction of a coparticipation law has not been complied with and a set of rules and agreements with different distribution criteria governs in its place (what usually receives the name of "The Coparticipation Labyrinth"). In this regard I can name the law N° 23,548 that determines the rates of primary distribution (42.34 % to the National Treasury, 56.66 % to the provinces and 1 % to National Treasury contributions) as well as secondary distribution (rates of distribution for each province) and some specific distribution treatment for taxes as the laws N° 20,628 and N° 26,078 for the Income Tax or the laws N° 23,966 and N° 26,078 for the Value Added Tax.

According to Piffano (2019) the labyrinth, and the discretion that arises because of its complexity, end up infringing the basic principles of accountability and transparency of fiscal and financial actions of governments.

One of the last mentions of the need to pass a law that regulates the coparticipation system took place in 2017 during the signing of a new national fiscal consensus. In the final document, among many other subjects, the federal government and the provinces agreed to pass a new law for the federal coparticipation of taxes to fulfill the constitutional mandate. Many topics of the fiscal consensus were fulfilled, but some other were postponed, among the last ones was the approval of a law of the coparticipation system.

Since a definite fiscal transfer system in Argentina is yet to be determined, this paper aims to make a contribution on the ongoing debate around the desire distribution mechanism that may be implemented when the topic gets back on the public agenda. More specifically, the paper will propose the rates of distribution each province should receive based on their expenditure needs.

The paper is organized as follows: Section 2 goes over the relevant literature on the matter. Section 3 presents the model from Langørgen (2015) that I will use to estimate the results. Section 4 describes the data from Argentina and the way I work with them. Section 5 introduces the estimation method that will be applied. Section 6 presents the empirical results for the Argentinian provinces. Finally, Section 7 discusses the most relevant conclusions.

2. Literature review

The debate about the justification of equalization transfers based on equity and efficiency is a barren and never ending one. There have always been arguments about how equalization payments induce inefficiency in the regional allocation of resources, being them human (discouraging outmigration of labor to more productive regions) or capital. For more discussion on this matter see Broadway (2003), where he discusses the optimality of decentralized decision-making and the efficiency and equity arguments for equalization.

However, if one is willing to ignore the conceptual objections and, as Shah (1994) says, embrace the prevalent view that equalization transfers are justified on efficiency and equity grounds, then the design of the fiscal transfer system would be the main concern. One common approach has been to think in terms of horizontal equity.

Horizontal equity refers to the principle that persons who are equally well-off before government policy should be equally well-off after it: equals should be treated equally. This concept has been extended by Buchanan's seminal paper (1950) to fiscal federalism to mean that the federal government should ensure that all its citizens are treated equally regardless of their place of residence.

According to this view, the overall condition of the individuals should be taken into consideration when designing the fiscal system. Hence, a comprehensive equalization scheme should clearly include both fiscal capacity and expenditure differential measures.

Expenditure needs have always been thought to be much more difficult to define and measure than is its revenue equivalent, fiscal capacity. Broadly, expenditure needs may be measured in three ways (Martinez-Vazquez and Boex, 2001). One method is to estimate the cost of providing a standardized set of public services. A simpler alternative is to rely on historical expenditure patterns and use observed average costs for various expenditures. A third possible approach is to set out a representative expenditure system (RES) analogous to the representative tax system (RTS) on the revenue side that I will describe later. Shah (1996) proposes a five-step way to determine such a system that was summarized by Vaillancourt and Bird (2004) as follows:

1 Disaggregate sub-national governments (SNG) expenditures into major functional categories such as health services, education, transportation and communication, etc. Identify significant determinants (needs/costs factors).

2 Determine the influence on spending levels of cost and need indicators such as those listed above, usually through regression analysis. This step requires thorough understanding of not only differences in service areas, populations and local needs but also of the objectives of public policy and the production functions (input-output relationships) of public services. It is also critical to understand possible strategic behaviors of recipient governments.

3 Establish the per capita standardized expenditure of SNG for each category ($PCSE_{x,i}$), employing national average values for the fiscal capacity indicators. What this procedure does is to establish how much a SNG would spend, given its needs and costs profile, for each specific expenditure category if it had 'average' revenue. The weight of each factor is obtained empirically using data on all regions, hence in principle this method should have the advantage of requiring objective standards.

4 Estimate the standardized per capita national expenditure for each category ($PCSE_{na,i}$) by evaluating the regression results at national mean values for all variables.

5 Using the equation below the equalization grant each SNG is entitled to can then be calculated:

$EE_{x,i} = POP_x * [PCSE_{x,i} - PCSE_{na,i}]$

$EE_{x,i}$ represents the equalization entitlement for region x for the spending category i, POP_x is the population of region x and $PCSE_{x,i}$ and $PCSE_{na,i}$ are the per capita standardized expenditure for region x and at national average for spending category i.

As was mentioned before, to ensure that the concept of horizontal equity is fulfilled not only the resources potentially available to finance public services but also the cost of providing those services must be considered.

This approach has been used by many authors who try to approximate the expenditure needs for the Argentinian provinces. Such is the case of Otero, Cerimedo and Mongan (2006), Minatta, Mongan and Montalvo (2013) and Porto (2016). The main difference among them is the method used in the second step to estimate the weights of each cost factor. While the first two papers use regression analysis, the third one relies on comparing relative spending amounts to determine the participation of each factor.

In this paper, however, I try to use a different approach that pretends to be a more holistic and factual representation of the reality based on Langørgen (2015) and I will give two main reasons for this statement.

First, expenditure differences in providing public services reflect two factors: cost differences and need differences, as Vaillancourt and Bird (2004) point out:

- Cost differences are differences in the cost per unit of a 'standardized' public service. They may arise from climatic or geographic features, density or distance factors, or differences in labor cost across regions.
- Need differences are differences in the number of units of standardized service required per capita. They usually arise owing to demographic reasons such as the age structure of the population and different participation rates in social programs by persons of different ages.

The structural model proposed by Langørgen (2015), considers both this matters in depth. It does so by exploiting the properties of a maximization problem over a Stone–Geary utility function for a given budget constraint for local governments, unlike just using a linear regression for each cost with relevant variables in a reduced form matter as it is common in the literature. I will discuss more deeply about the model in the next section.

Second, it highlights the importance of comparing results between a reduced form and a structural model. As Langørgen (2015) points out: measures of expenditure needs are frequently derived by employing regression-based methods. However, the biggest problem with them is that it turns out very difficult to provide a valid definition of expenditure needs as a function of reduced form parameters. The main issue is that structural parameters are defined to characterize preferences and cost functions, whereas reduced form parameters measure the partial marginal effect of a change in a given exogenous variable on different endogenous variables. It is natural to think that this partial marginal effect combine different effects and it is impossible to precisely determine the impact of each one.

In his paper, Langørgen claims that: "... the information contained in reduced form parameters does not distinguish between effects on minimum expenditure needs and discretionary incomes. (...) This is because the reduced form parameters identify marginal effects on expenditures rather than on expenditure needs."

On the other side, going back to general equalization scheme models, the fiscal capacity of a province is defined by its ability to raise revenues from its own tax bases. Assuming that 'own' tax bases are clearly defined, there are several methods that may be employed to determine fiscal capacity in this sense, as Shah (1994) and Martinez-Vazquez and Boex (2001) demonstrate.

The simplest to implement are measures based on current or past years' revenue collections. However, such measures raise some problems that need to be considered. For instance, the

potential ability to raise revenue is not directly affected by tax rates, but fiscal effort and taxpayer compliance and actual revenues are affected, so it may produce an endogenous response to it. Hence, when current revenue collection is used as a measure of fiscal capacity, it may provide provinces with an obvious incentive to impose lower tax rates or to make less effort to collect taxes in order to receive higher equalization grants. Although using past collections would seem to alleviate this problem there remains a problem of time-inconsistency if the rates are expected to be updated every once in a while, using this past information.

Despite its numerous problems, I choose to use the actual data of provinces' incomes because even though some information about their tax rates and bases could be obtained from different sources, there are several differences among their incomes. For example, the most important one is the hydrocarbon royalties. The hydrocarbon royalties are the right to collect compensation for the extraction of the hydrocarbon product, given that the oil or gas belongs to the province in which underground territory the resource was found. Besides this, there are some provinces benefiting from regional development programs, therefore they have significant tax benefits, and, in some cases, they also receive relatively more resources of national origin outside the co-participation system that is the central objective of analysis in this paper.

There exist, however, other methods to study the fiscal capacity of the SNG. For instance, I may use the regional income or output. Even though it is a more reliable method than past data on taxes information, it still can arise some issues. For instance, the measured personal income for a given SNG may be a reasonable measure of the average ability of its residents of generating wealth liable to be taxed, but it may not be an accurate indication of the ability of the SNG to impose taxes. Nevertheless, the biggest problem when using this method for Argentina is that it does not exist an official source for Gross Regional Product (GRP) estimation. There have been many authors who produce their own data series of GRP, see Ferrer (2004), and many publications about their own GRP by each province.

The other possible method the literature usually refers to is the representative tax system (RTS), which measures the amount of revenue that could be raised by a SNG if it uses 'standard' tax bases and 'standard' (usually average) tax rates. As expected, is very similar to the representative expenditure system (RES) mentioned before. The biggest difficulty with this approach is that, to use it properly, information on tax bases and tax revenues for every region is needed and, unfortunately, is not something publicly available for most provinces, especially the tax bases.

3. Model

As was mentioned above, the structural model proposed by Langørgen (2015) takes into consideration the two fundamental factors that determine the expenditure differences among provinces and justify the intervention of the national government: cost differences and need differences.

Even though the model used by Langørgen (2015) is quite general, for this paper I use it but with some simplifications discussed in the following section. Despite that, all the variable names and descriptions come from his paper, so the notation will be the same.

In the model presented by Langørgen (2015) local governments are assumed to have preferences regarding tax burden and levels of output on S service sectors, distributed to J different target groups. A target group is defined as a group of people with equal needs for public

services. Tax burden is treated as a negative good and depends both on the local tax rate and on the size of the local tax base. The utility U_k of local government k is assumed to be given by the following specification of a Stone–Geary utility function:

$$U_k = \theta_k \log(\kappa_k - v_k) + \sum_{i=1}^{S} \sum_{j=1}^{J} \beta_{ijk} \log(x_{ijk} - \gamma_{ij}) \tag{1}$$

where v_k is interpreted as the tax income, and x_{ijk} is the production of service i per person of target group j in municipality k. In Langørgen (2015), the sub-national government agent is the municipality, however, for this paper the local government would be the province. The parameter γ_{ij} denotes the minimum quantity per person of service i targeted to group j and Langørgen (2015) proposes it can also be considered as a measure of the local governments' common assessment of the need for different services targeted to different population subgroups. Hence, minimum quantity parameters can be named needs parameters. By contrast, the parameter β_{ijk}, which can be interpreted as the marginal budget share for spending on group j in service sector i, can vary across municipalities. The parameter θ_k is equal to the marginal budget share distributed to the private sector as a reduction in the tax burden. To be consistent with the budget constraint, the marginal budget share parameters satisfy the adding-up constraint $\theta_k + \sum_{i=1}^{S} \sum_{j=1}^{J} \beta_{ijk} = 1$. The parameter κ_k is interpreted as the maximum acceptable level of local taxes.

The Stone–Geary utility function introduces a subsistence level of consumption to the usual Cobb-Douglas utility, and has most of the same properties: monotone, concave and additively separable, however it is not homothetic. The intuition behind the Stone–Geary utility function is that consumers (or in this case, local governments) first set aside subsistence levels of goods, then allocate remaining budget in proportion to the marginal budget shares. Since the expenditure function for the Stone–Geary utility is linear in income and prices, it is often called the linear expenditure system.

To better describe the cost composition, the author decomposes it in fixed and variable costs. As described by Langørgen (2015), local governments face fixed costs in the production of public services because municipalities need administrative and political management, have a legal duty to keep accounts, and must maintain a basic stock of buildings and service functioning to be able to operate. These costs are considered fixed because, at least in the short run, they hardly vary with the amount of production of different services. Moreover, fixed costs do not increase with the size of the municipality and are supposed to be the same for every local government. Hence, it is expected for fixed costs to be relatively high for small municipalities.

As for the variable costs, the paper assumes that the cost per unit of service of production may vary across municipalities and service sectors. However, the unit cost does not vary as a function of output in the model, which implies that the production functions are assumed to exhibit constant returns to scale. In order to distinguish between fixed and variable costs, Langørgen (2015) defines total expenditure in service sector i as:

$$u_{ik} = \frac{\alpha_{ik}^{F}}{n_k} + \pi_{ik} x_{ik}, \ i = 1, 2, ..., S, \tag{2}$$

where u_{ik} is expenditure per capita in service sector i, α_{ik}^F denotes the fixed cost in service sector i, n_k is the population size of municipality k, the unit cost in the production of service i is π_{ik}, while variable costs in sector i are defined by $\pi_{ik}x_{ik}$. The production x_{ik} in service sector i is allocated to target groups as follows:

$$x_{ik} = \sum_{j=1}^{J} x_{ijk} z_{jk}, \ i = 1, 2, ..., S, \tag{3}$$

where z_{jk} is the population share that belongs to target group j.

Using these equations, the author defines the budgets of the local governments. The budget constraint requires total incomes (minus fixed costs) to be allocated to spending on different service sectors and target groups. From (2) and (3), the budget constraint is defined as:

$$y_k + v_k = \sum_{i=1}^{S} u_{ik} = \sum_{i=1}^{S} \frac{\alpha_{ik}^F}{n_k} + \sum_{i=1}^{S} \pi_{ik} \sum_{j=1}^{J} x_{ijk} z_{jk} \tag{4}$$

where y_k is the block grant per capita received by local government k. Total income $(y_k + v_k)$ is the sum of block grant and tax income.

By maximizing the utility (1) subject to the budget constraint (4), the following expenditure system is obtained, for $i = 1, 2, ..., S$ and $j = 1, 2, ..., J$:

$$\begin{aligned} \pi_{ik} x_{ijk} z_{jk} &= \alpha_{ijk}^V + \beta_{ijk} \left(y_k + \kappa_k - \frac{\alpha_{+k}^F}{n_k} - \alpha_{++k}^V \right) \\ v_k &= \kappa_k - \theta_k \left(y_k + \kappa_k - \frac{\alpha_{+k}^F}{n_k} - \alpha_{++k}^V \right) \end{aligned} \tag{5}$$

where Langørgen (2015) describes $\alpha_{ijk}^V = \pi_{ik}\gamma_{ij}z_{jk}$ as the minimum variable cost in sector i targeted to group j, $\alpha_{++k}^V = \sum_{i=1}^{S} \pi_{ik} \sum_{j=1}^{J} \gamma_{ij} z_{jk}$ as the total minimum variable cost in municipality k, and $\alpha_{+k}^F = \sum_{i=1}^{S} \alpha_{ik}^F$ as the total fixed cost in municipality k. Discretionary income is defined by $y_k + \kappa_k - \frac{\alpha_{+k}^F}{n_k} - \alpha_{++k}^V$, which is the potential income remaining when the fixed costs and minimum variable costs have been covered.

The author points out that the actual allocation of expenditures and production to target groups is usually not observed in the data, which means that the β_{ijk} parameters are not directly identified. Therefore, Langørgen (2015) considers an aggregate version of the equation system, in order to overcome the problem that data for local governments account for spending in service sectors, rather than production towards target group. The modified equations are obtained by inserting (3) and (5) into (2):

$$
\begin{aligned}
u_{ik} &= \frac{\alpha^F_{ik}}{n_k} + \alpha^V_{i+k} + \beta_{ik}\left(y_k + \kappa_k - \frac{\alpha^F_{+k}}{n_k} - \alpha^V_{++k}\right),\ i = 1, 2, ..., S, \\
v_k &= \kappa_k - \theta_k\left(y_k + \kappa_k - \frac{\alpha^F_{+k}}{n_k} - \alpha^V_{++k}\right)
\end{aligned}
\tag{6}
$$

where $\beta_{ik} = \sum_{j=1}^{J} \beta_{ijk}$ is the marginal budget share for service sector i and

$$
\alpha^V_{i+k} = \pi_{ik} \sum_{j=1}^{J} \gamma_{ij} z_{jk}\ i = 1, 2, ..., S, \tag{7}
$$

is equal to the minimum variable cost in service sector i. Minimum required expenditure is defined by the sum of fixed costs and minimum variable costs in each service sector and poses a spending commitment which local governments are expected to meet.

The equation system in (6) is the main result from Langørgen (2015), because it determines the equations to be estimated in order to obtain the measures of expenditure needs required to propose an alternative equalization scheme.

For the purpose of this paper, however, I need to make some modifications to the original model from Langørgen (2015). This is due to the fact that some of the required data are not accessible or, if attainable, using them will require the inclusion of many more variables and parameters that would end up significantly reducing the number of degrees of freedom in the data that, as I will show in the next section, it is really low when compared to the data set used by Langørgen (2015).

For instance, one of the modifications that I will need to apply is the simplification of target groups j. That is, all the service sector i's production will be allocated only into one target group. This does not mean the target group will necessarily be the entire population. For example, the education provided by the provinces will be destined to the young people based on enrollment data, but Langørgen (2015) takes into account other target groups for this service sector considering refugee status as well. I will elaborate on these modifications to the original model in the following section.

4. Data

For the estimation of the model, I use data from the 23 provinces of Argentina, excluding Buenos Aires City. The City of Buenos Aires was not considered because its expenditure's attributions are considerably different from those of the rest of the jurisdictions. For instance, in its territory it presents a limited exercise of the security and justice functions. Historically, the City of Buenos Aires did not have its own police force and its security depended on the Federal Police. It was not until 2008 when Buenos Aires City created its own police force: the Metropolitan Police, to later fused it with a division of the Federal Police to found the City Police. Hence, Buenos Aires City's spending on security has been increasing ever since so it is difficult to compare with the rest of the provinces. Moreover, the City of Buenos Aires does not have a

prison system of their own, even though it poses some prisons on its territory they belong to the federal justice's orbit, hence its overall spending on the security and justice functions are quite different than the other provinces. On the other hand, Buenos Aires City oversees the provision of many urban services that, in the case of the other provinces, are mainly exercised by the municipalities, since it has to take care of streets' maintenance, parks and squares, streetlights, household garbage collection, and so on. Most of these services are usually provided by the local municipalities inside each province, so it constitutes a relevant difference in spending allocation as well.

The data sample size given by the 23 provinces that make up Argentina is significantly small compared to the one used by Langørgen (2015). The author gets his dataset from a cross section of 402 observations of Norwegian municipalities from 2008. In order to obtain representative results, I combine cross section data from four years for the 23 Argentinian provinces, totaling 92 observations. The year selection is based on available data, some standard time separation and the avoidance of electoral years. Taken into account these considerations, I choose 2006, 2010, 2014 and 2018 as years from which to extract the data.

Given the high rates of inflation through this period, I use real variables as of 2006, to enable comparison among data from different years. Therefore, all the information expressed in monetary unit should be understood as measured by the price level from 2006.

The usage of this combination of cross section data is necessary to achieve significant estimates. However, its main disadvantage is the fact that most of the spending into the different services generally increase over time, even at constant prices. So, there are certain results and conclusions that Langørgen (2015) obtains in his paper that I will not be able to reproduce for Argentina. For instance, considering that the total amount of national transfers in my data does not totalize the whole grants of a certain year but the summation of many periods, it cannot be used to calculate the optimal level of central government allocation that satisfies the condition of horizontal equity for a given year which is one of Langørgen (2015) main results. Accordingly, if I try to estimate it with the complete data for all the provinces for the four years the conclusion that arises is that the provinces from 2006 and 2010 receive too much national intergovernmental fiscal transfers, while the same districts but between 2014 and 2018 receive, in general, too little of these transfers to obtain horizontal equity. Despite the fact this may or may not be true for some cases, the real reason behind this result is that, as expressed before, the per capita spending at constant prices increases consistently over the years for all provinces. It is important to mention these topics properly since they speak about the limitations of the data.

The data on provinces' spending during the period under analysis comes from the National Directorate of Provincial Affairs (DNCFP for its acronym in Spanish). The same is true for the information about provincial tax resources. It is worth mentioning, however, a few considerations about this information.

First, the spending at the provincial level in Argentina is quite heterogeneous. This does not only imply that every local government has a rather wide range of possibilities when it comes to choosing in what to spend their income, but also that not every jurisdiction spends in every single type of service. For instance, there are a few provinces that do not have their own social security system, which means that their employees contribute and retire using the national system (ANSES for its acronym in Spanish). The same occur with Other Urban Services, when some provinces register zero spending into that service category. On the other side, there exist several spending categories that are usually funded by both provincial and the national government, such as Housing and Urban Planning or Drinking Water and Sewerage or some Economic Services and Promotion and Social Assistance programs. In all these cases, there usually are national funds

allocated to the local governments, using somewhat discretionary distribution criteria. Therefore, some of the spending into these services is funded by special national transfers that do not obey a standardized distribution scheme. In fact, they are rather political and is quite difficult to keep track of all of them and even more, to collect information about the distribution criteria and the amount received by every district. Given that most of these transfers are designated to a specific purpose they cannot be used to pay salaries or to buy goods outside those of the particular program's goal. For that reason, special national transfers of this kind can be circumscribed into some of the spending categories that were mentioned before. Consequently, in order to control for this political and discretionary spending and to avoid the categories that are not shared by all the districts, I decide to focus on the spending into four major services that are common to every province and that are funded either by the local government or by the national coparticipation system which is the main object of study in this paper. These spending categories are: Government Administration, Security Services, Health Care and Education and Culture. Together these four services constitute more than 75 % of the total provinces' spending, so it is safe to say they are a representative sample of how the local governments use their available income.

The information about spending is presented in Table 1. The quantities should be considered in millions of pesos as of 2006. To better study the data the combined cross section sample is featured first (with the 92 observations) and the summary statistics for each year (with 23 observations each) follow.

As was mentioned before, the average spending grows with time. Moreover, it can be noted that there is an increase in the standard deviation as well. This implies that not only the average per capita spending increases, but also the dispersion of data grows over time meaning the differences among provinces do not seem to converge during the years in the sample in real terms.

Secondly, the provincial tax resources data that can be downloaded from the National Directorate of Provincial Affairs was also modified because the information obtained by this source consists of the basic taxes a province can collect, that are: gross income tax, property taxes on housing and stamp tax, to name the most important ones. However, there exist other sources of income that certain provinces possess, and that can be extremely important for their local economy. The most significant one is the hydrocarbon royalties. The hydrocarbon royalties are the right to collect compensation for the extraction of the hydrocarbon product, given that the oil or gas belongs to the province in which underground territory the resource was founded. There are certain provinces such as Chubut, Neuquén and Santa Cruz for which these royalties more than double their income from the previously named taxes. Undoubtedly, they are incomes that should be considered for a proper analysis on the matter. This criterion is also followed by Porto (2016). The data about hydrocarbon royalties comes from the Secretary of Energy, who inform quantities and prices sold from each province of oil, natural gas, gasoline and liquefied natural gas.

The information about provincial tax resources is summarized in Tables 2 and 3. First there is a complete list for every province's tax income, and then some summary statistics. All the numbers are expressed in millions of pesos of 2006.

We can see that the tax income went through a similar path that the provinces' spending counterpart. The average tax income increased over time and the same happened to the standard deviation. Even though this process is worth studying in more depth, it can be argued that the provinces' financing scheme did not drastically changed during the time period included in the sample, since both their average spending and average income experience similar growth paths.

Table 1: Provinces' spending by categories

Sector	Average	Standard Deviation	Minimum	Maximum
2006, 2010, 2014, 2018				
Administration	1,208.87	1,567.81	273.58	9,390.46
Security	450.57	818.89	68.76	5,395.16
Health Care	470.25	516.49	103.11	3,210.18
Education and Culture	1,408.86	2,219.95	277.75	12,751.64
2006				
Administration	913.81	1,141.62	273.58	5,859.11
Security	296.53	526.65	68.76	2,607.91
Health Care	313.20	360.89	103.11	1,869.78
Education and Culture	1,036.97	1,780.30	277.75	8,950.00
2010				
Administration	1,138.70	1,543.11	352.39	7,845.10
Security	378.19	637.28	93.48	3,130.26
Health Care	441.79	505.73	126.94	2,592.41
Education and Culture	1,375.85	2,257.02	352.87	11,370.68
2014				
Administration	1,317.09	1,692.03	406.89	8,632.95
Security	538.05	914.41	124.26	4,524.99
Health Care	531.53	520.63	172.12	2,668.60
Education and Culture	1,569.00	2,333.65	398.57	11,687.18
2018				
Administration	1,465.87	1,855.37	461.21	9,390.46
Security	5589.49	1,093.48	127.80	5,395.16
Health Care	594.47	632.19	159.54	3,210.18
Education and Culture	1,653.60	2,537.74	424.55	12,751.64
92 observations in the combined data and 23 observations for each year				

Note: Values are expressed in millions of 2006 Argentinian pesos.
Source: Own calculation based on DNCFP data.

To estimate the variable cost of the inputs, the main source of information were the wages. The data on wages paid at different services is based on the Permanent Households Survey (EPH for its acronym in Spanish) elaborated by the National Institute of Statistics and Census (INDEC). The EPH consists of interviews to a representative sample of households at different urban agglomerates (major cities) around the country. It collects information related to demographic and socioeconomic characteristics of the population. Among the many questions asked during its interview, there are inquiries about current main job, income received for such main job and a National Classifier of Occupations (CNO). With this information about a representative sample of a province´s population, I can estimate the average salary paid at each public service for every year of the analyzed period.

The information about wages is presented in Tables A.1 to A.5 in the Appendix. The quantities should be considered in pesos from 2006. Once again, to study the data from every specific year, first there is a table from the combined cross section sample and then there is one table for each year.

When we analyze the average salaries information, we may come up with some interesting conclusions. For instance, the average salaries in the Administration sector increased significantly

Table 2: Provinces' tax income per year

Province	2006	2010	2014	2018
Buenos Aires	10,602.00	12,896.80	16,836.51	17,845.30
Catamarca	115.78	156.78	195.41	207.97
Chaco	249.24	347.13	540.15	572.39
Chubut	1,325.28	1,217.79	1,407.95	1,489.26
Córdoba	1,848.88	2,541.10	3,363.67	3,633.94
Corrientes	202.32	259.60	371.03	421.89
Entre Ríos	622.76	675.45	1,176.98	1,215.78
Formosa	95.77	122.80	172.98	189.42
Jujuy	146.32	178.85	256.85	313.49
La Pampa	325.09	344.18	442.96	487.23
La Rioja	79.27	79.05	113.22	146.23
Mendoza	1,509.98	1,364.31	2,182.86	2,276.38
Misiones	370.81	444.84	845.10	854.99
Neuquén	2,075.34	1,682.04	2,001.48	2,930.36
Río Negro	621.45	594.97	856.06	939.28
Salta	625.34	623.34	670.96	963.37
San Juan	229.92	302.32	385.63	387.35
San Luis	266.29	315.62	430.32	477.27
Santa Cruz	1,155.47	894.65	1,217.00	1,102.68
Santa Fe	1,886.45	2,434.82	2,962.81	3,397.14
Santiago del Estero	184.99	221.35	287.65	326.82
Tierra del Fuego	446.17	318.44	458.27	567.36
Tucumán	602.07	826.84	1,117.45	1,256.22
92 observations				

Note: Values are expressed in millions of 2006 Argentinian pesos.
Source: Own calculation based on DNCFP and the National Secretary of Energy data.

from 2006 to 2010, but then it seems to have stagnated. The Education and Culture sector seems to have experienced the same process in term of its average salaries. Using this information, in order to explain the always increasing per capita spending on these sectors during the period analyzed, it can be argued that the rise is mostly driven by an expansion in public employment rather than an increase in wages.

As for the other two service sectors, Security and Health Care, their average salaries increased consistently from 2006 to 2014 to finally slow down and even get reduced in 2018. Hence, the previous argument about the expansion of public employment seems to be more relevant in the last couple of years, but it is not observable during the previous years in the sample.

5. Estimation

The model is estimated using a Seemingly Unrelated Regression (SUR). I make use of this method because in the model there are several linear equations, and it is often unrealistic to expect that the equation errors would be uncorrelated. A set of equations that has contempora-

Table 3: Provinces' tax income per year - summary statistics

Year	Average	Standard Deviation	Minimum	Maximum
2006	1,112.48	2,162.43	79.27	10,602.00
2010	1,254.05	2,631.30	79.05	12,896.80
2014	1,664.93	3,424.31	113.22	16,836.51
2018	1,826.18	3,637.22	146.23	17,845.30
23 observations per year				

Note: Values are expressed in millions of 2006 Argentinian pesos.
Source: Own calculation based on DNCFP and the National Secretary of Energy data.

neous cross-equation error correlation is called a seemingly unrelated regression (SUR) system. And as was proved by Zellner (1962), under certain conditions, it is found that estimating using SUR may lead to more efficient estimates than running the models separately.

Seemingly unrelated regression models are so called because they appear to be joint estimates from several regression models, each with its own error term. The regressions are related because the errors associated with the dependent variables may be correlated.

When we fit models with the same set of right-hand-side variables, the seemingly unrelated regression results (in terms of coefficients and standard errors) are the same as fitting the models separately. However, when there are differences as in this case, then by allowing the error terms to be correlated the full variance–covariance matrix of the coefficients is estimated, and we should expect different results than those obtain by an equation-by-equation application of least square. In general, in this case the coefficients are slightly different, but the standard errors are uniformly smaller. To test the hypothesis of existence of this correlation among the errors, there exists the Breusch and Pagan test. This consists of a χ^2 statistic (a Lagrange multiplier statistic) that for this model generates the results that can be seen in Table 4.

Table 4: Correlation matrix of residuals

	Administration	Security	Health Care	Education and Culture	Tax Income
Administration	1.0000				
Security	0.4104	1.0000			
Health Care	0.3701	0.5844	1.0000		
Education and Culture	0.4349	0.6304	0.7426	1.0000	
Tax Income	0.4583	0.3429	0.3749	0.4214	1.0000

Breusch-Pagan test of independence: chi2(10) = 223.612, Pr = 0.0000

I find that, for the different equations of the model, the correlation of them is rather considerable. Hence, we can reject the hypothesis that this correlation is zero, which is the null hypothesis of the Breusch and Pagan test.

Now that the estimation method is decided, I can start analyzing some results from the Seemingly Unrelated Regression.

First, in terms of goodness of fit, the R-squared reported is the percent of variance explained by the predictors. Even though R-squared does not carry the same properties from OLS when GLS is used instead, it still can be used for descriptive purposes. The R-squared for this model are presented in Table 5.

Table 5: Seemingly Unrelated Regression

Equation	Obs.	Params.	RMSE	R2	chi2	pv.
Administration	92	6	243.97	0.883	724.80	0.00
Security	92	6	80.42	0.784	344.85	0.00
Health Care	92	6	133.82	0.748	271.62	0.00
Education and Culture	92	6	233.02	0.833	470.38	0.00
Tax Income	92	2	598.16	0.715	219.36	0.00

Obs.: observations. Params.: parameters. RMSE: root mean squared error. R2: R-squared. chi2: χ^2. pv: p-value.

The model predicts more than 70 % of each equation's variance. Moreover, the model fit is fairly high for the larger service sectors such as Administration and Education and Culture.

For the estimation, as was mentioned at the end of Section 3, I use a simpler version of the model. For instance, I use four different service sectors ($S = 4$), but each one has associated only one targeted group j ($J = 1$). This was done because of lack of data and to facilitate the estimation given the more parsimonious model. It could be argued that the targeted group used for each of the four sectors is fully representative. This remark is made since for Administration, Security and Health Care, the complete population was considered as the targeted group, and for Education it was aimed only to children in schools based on enrollment data. However, Langørgen (2015) uses other categories such as employment status, poverty status and so on. Despite this simplification, the model takes into account every important feature of reality and predicts the real costs a province must incur in order to provide every public service.

6. Results

The Seemingly Unrelated Regression presented in the previous section allows me to obtain the reduced form parameters for the four service sectors and the provincial tax income. The results from the estimation are presented in the Table 6.

Where the regressors are the inverse population size to estimate the fixed cost in each service (α^F_{+k}), the average wages in each service times the share of the population that receives such service (α^V_{i+k}), the per capita national transfers that each province received (y_k) and the per capita labor income earned by the province's population as a measure of fiscal capacity (κ_k).

After that, the structural parameters can then be recovered from a system of linear equations when each reduced form parameter can be decomposed into several structural ones according to the following general equation:

$$u_{ik} = \lambda_i \frac{1}{n_k} + \phi_{ij}\pi_{ik}z_{jk} + \beta_i y_k, \ i = 1, 2, ..., S, \tag{8}$$

where λ_i is the reduced form parameter for the fixed cost estimated through the inverse of population, and ϕ_{ij} is the reduced form parameter for the population share times the unit cost for spending on service sector i. The reduced form parameter for provincial tax income is the marginal budget share β_i, which turns out to be equal to the structural parameter for the local government's preferences.

Table 6: SUR estimates

	Administration	Security	Health Care	Education and Culture	Tax Income
Inverse population * one million	252.87*** (30.09)	15.07 (10.53)	16.38 (17.28)	84.71*** (29.37)	
Adm. wages * pop. %	0.614*** (0.155)	0.160*** (0.054)	0.005 (0.089)	0.455*** (0.151)	
Sec. wages * pop. %	0.265** (0.124)	0.177*** (0.043)	0.033 (0.071)	0.259** (0.121)	
Hea. wages * pop. %	-0.214* (0.125)	-0.016 (0.044)	0.268*** (0.072)	0.072 (0.122)	
Edu. wages * pop. %	0.424 (0.683)	0.199 (0.239)	0.885** (0.393)	1.866*** (0.667)	
National transf. p.c.	0.188*** (0.044)	0.029* (0.015)	0.074*** (0.025)	0.129*** (0.042)	-0.176** (0.080)
Labor income p.c.					2.662*** (0.184)
Constant	-645.83*** (157.009)	-246.40*** (54.166)	-333.84*** (89.139)	-741.29*** (152.430)	-1452.20*** (211.622)

$^{*}p < 0{,}1$; $^{**}p < 0{,}05$; $^{***}p < 0{,}01$

From this equation, I can express the reduced form parameters in terms of structural parameters using the equations in (6) as follows:

$$\begin{aligned} \lambda_i &= \alpha_{ik}^F - \beta_i \sum_{i=1}^{S} \alpha_{ik}^F, \ i = 1, 2, ..., S, \\ \phi_{ij} &= \gamma ij - \beta_i \sum_{i=1}^{S} \gamma ij, \ i = 1, 2, ..., S, \end{aligned} \tag{9}$$

where α_{ik}^F and γij are the structural parameters I am looking for in order to properly estimate the expenditure needs.

As Langørgen (2015) points out, the reduced form parameters for the case of normal goods such as these services will differ from structural parameters. The author also interprets these differences between parameters as the change in discretionary income allocated to services sector i given a marginal change on some of the variable costs. Hence using the reduced form parameter is not enough to estimate the marginal effects on expenditure needs because they cannot be distinguished from effects on discretionary incomes, but rather they both get combined in a single estimated parameter.

Consequently, to correctly estimate the expenditure needs I need to use the structural parameters. Since reduced form parameters are basically a linear combination of structural parameters, I solve the system of linear equations to recover them.

Using the equations just shown, I estimate the per capita costs that every province should face in order to provide its citizens with the four aforementioned public services. It is important to remember that the monetary values are in real terms as of 2006.

The estimated fixed cost for each service using both approaches are displayed in Table 7.

Table 7: Fixed Costs per province

Sector	Structural Form	Reduced Form
Administration	$ 372.70	$ 252.87
Security	$ 33.68	$ 15.07
Health Care	$ 63.19	$ 16.38
Education and Culture	$ 167.04	$ 84.71

Note: Values are expressed in millions of 2006 Argentinian pesos.
Source: Own estimations.

The reduced form fixed costs are simply the estimates I obtained from the SUR for each service sectors. As for the structural form values I got them from solving the system of linear equations obtained from (9).

Table 7 shows that the estimated reduced form parameters are consistently smaller than the structural form estimates. This result comes from the following explanation given by Langørgen (2015):

> "... the information contained in reduced form parameters does not distinguish between effects on minimum expenditure needs and discretionary incomes. Moreover, when cost factor h or target group j affects expenditure needs in more than one service sector, the corresponding reduced form parameters conflate expenditure needs from different service sectors. This is because the reduced form parameters identify marginal effects on expenditures rather than on expenditure needs."

In other words, whenever the marginal budget share parameters are positive (which is the case for normal goods), reduced form parameters differ from structural parameters and given the former are a linear combination of the latter, then they should always be smaller. This could interpreted as if the reduced form parameters consistently underestimate the effects on expenditure needs.

Undoubtedly, this result represents one of the main arguments in favour of the structural estimation. Any attempt to recover expenditure needs parameters using a reduced form approach will be downward biased. Therefore, a policy recommendation based on those estimates will consistently fall short in its attempt to impact the provinces' financial scheme as desired.

As for the total variable costs, they are estimated for every province in each year of the sample because the population and the cost per unit change for each case (unlike the fixed cost that is the same for the whole sample). Hence, there would be 92 values for structural and reduced form estimates. For the case of jurisdictions in 2018, the variable costs are presented in Table 8. The rest of the values for other years are presented in Tables A.6 to A.8 in the Appendix.

The reduced form values come from multiplying the respective estimated parameter from the SUR times their regressor times the population and summing up for the four services (for

Table 8: Total Variable Costs for all sectors in 2018

Province	Structural Form	Reduced Form
Buenos Aires	$ 48,761.46	$ 34,123.91
Catamarca	$ 1,004.03	$ 705.44
Chaco	$ 2,955.74	$ 2,058.61
Chubut	$ 1,923.67	$ 1,355.87
Córdoba	$ 11,118.73	$ 7,800.93
Corrientes	$ 2,308.22	$ 1,625.42
Entre Ríos	$ 3,475.90	$ 2,421.82
Formosa	$ 1,700.81	$ 1,214.90
Jujuy	$ 1,902.31	$ 1,350.19
La Pampa	$ 1,192.43	$ 850.35
La Rioja	$ 873.84	$ 631.06
Mendoza	$ 5,516.24	$ 3,800.01
Misiones	$ 3,088.86	$ 2,167.18
Neuquén	$ 2,306.37	$ 1,632.11
Río Negro	$ 2,223.28	$ 1,593.56
Salta	$ 4,076.41	$ 2,883.33
San Juan	$ 1,877.89	$ 1,319.08
San Luis	$ 1,397.41	$ 996.80
Santa Cruz	$ 1,092.58	$ 765.98
Santa Fe	$ 9,520.31	$ 6,599.75
Santiago del Estero	$ 1,848.60	$ 1,304.86
Tierra del Fuego	$ 693.40	$ 487.69
Tucumán	$ 4,324.76	$ 3,072.19

Note: Values are expressed in millions of 2006 Argentinian pesos.
Source: Own estimations.

example, to get the variable cost from security for some province, I multiply 0.177 x w_sec*sh x population). As for the structural form values the procedure is the same, except the deep parameter is obtained through the linear system of equations from (9).

Like in the fixed costs case, the structural estimation results are consistently larger than the reduced form estimates.

It is easy to see that most of the cost the provinces should covered in order to provide all the services are variable costs, which main component are wages. Now we have a way to quickly compare the differences in spending needed for each local government. Buenos Aires is by far the province which the largest variable costs. Not surprisingly, it is also the largest province in terms of population.

Adding together the fixed costs and the variable costs I can obtain the Spending Needs (SN) for every province, together with their Relative Spending Needs (RSN) for a given year. The RSN is simply the relative weight of each province in the whole SN of the country in a particular year. Results for 2018 are displayed in Table A.9, in the Appendix.

On the other side of the fiscal equation, we have the Provincial Tax Income. As was already explained, although the literature tries to estimate the fiscal capacity using different methods, I choose to use the actual data of provinces' income. The main purpose of doing so is because, even though some information about provinces' tax rates and bases could be obtained

from different sources, there are several differences among their incomes, being the hydrocarbon royalties the most important one.

Using this information, I can approximate the Fiscal Capacity (FC) as well as the Relative Fiscal Capacity (RFC) for the same year as can be seen in Table A.10 in the Appendix.

With this, I have estimated relative indicators of the needs and resources each province has. Note, however, that the biggest contribution of this paper is to calculate the amount in pesos that every jurisdiction needs to be compensated for in order to properly offer its own basic services to its population.

By doing simple math, I can compute the Fiscal Disparity (FD) that comes from the subtraction of the Fiscal Capacity minus the Spending Needs. The sum of these fiscal disparities from all provinces amounts for the total quantity the national government should transfer to the jurisdictions in order to allow them to provide the services of Government Administration, Security, Health Care and Education and Culture.

With the information of Fiscal Disparity, I can obtain relative rates of distribution of the national transfers each province needs. These rates represent a new equalization scheme, that distributes the money from the actual coparticipation system in a different manner. These results are presented in Table 9. Since the mapping between reduced form coefficients and distribution rates (DR) is not linear, the standard deviations were obtained by bootstrapping. I estimate the distributions rates for 1000 samples with replacement and calculate the standard deviation of those rates for each province.

By checking the distribution rates and their corresponding standard deviations it can be seen that most provinces present very little variation in their rates. The only exception being the case of Buenos Aires, but relatively to its distribution rate such variation is pretty small. This implies that the estimates are pretty robust to changes in the sample since the bootstrapping was done without any stratification (for example, given the time trend discussed in Section 4 it could be reasonable to stratify by year), which provides evidence for the model's internal validity. Thus, it can be argued that the estimates fulfill their role of being structural parameters representing utility and costs functions.

Finally, I can compare these estimated distribution rates (DR) for 2018 spending needs and fiscal capacity of each Argentinian province with the actual rates used to transfer the coparticipation funds to the local jurisdictions. The first column in Table 10 displays the estimated DR using the structural approach from this paper. The second column shows the DR from the actual scheme, while the next couple of columns presents the difference in percentage points and the percentage difference between the first two columns, respectively.

It is useful to compare these results with the distribution rates other authors have proposed. For example, Porto (2016) uses a reduced form method to estimate the distribution rates. His results are presented in the fifth column of Table 10. Same as before, the next two columns display the difference in percentage points and the percentage difference between Porto (2016) estimates and the ones obtained using the structural approach.

Table 9: Provinces' Distribution Rates in 2018

Province	Fiscal Disparity	DR	DR SD
Buenos Aires	$ 31,552.76	35.93 %	1.07 %
Catamarca	$ 1,432.66	1.63 %	0.10 %
Chaco	$ 3,019.95	3.44 %	0.07 %
Chubut	$ 1,071.00	1.22 %	0.08 %
Córdoba	$ 8,121.39	9.25 %	0.15 %
Corrientes	$ 2,522.92	2.87 %	0.07 %
Entre Ríos	$ 2,896.72	3.30 %	0.05 %
Formosa	$ 2,148.00	2.45 %	0.09 %
Jujuy	$ 2,225.42	2.53 %	0.08 %
La Pampa	$ 1,341.80	1.53 %	0.10 %
La Rioja	$ 1,364.21	1.55 %	0.11 %
Mendoza	$ 3,876.46	4.41 %	0.11 %
Misiones	$ 2,870.47	3.27 %	0.07 %
Neuquén	$ 12.62	0.01 %	0.07 %
Río Negro	$ 1,920.60	2.19 %	0.08 %
Salta	$ 3,749.64	4.27 %	0.09 %
San Juan	$ 2,127.14	2.42 %	0.08 %
San Luis	$ 1,556.75	1.77 %	0.09 %
Santa Cruz	$ 626.50	0.71 %	0.10 %
Santa Fe	$ 6,759.77	7.70 %	0.15 %
Santiago del Estero	$ 2,158.38	2.46 %	0.08 %
Tierra del Fuego	$ 762.63	0.87 %	0.11 %
Tucumán	$ 3,705.15	4.22 %	0.07 %

DR: distribution rates. DR SD: distribution rates standard deviation.
Note: Values are expressed in millions of 2006 Argentinian pesos.
Source: Own estimations.

From the analysis of the distribution rates, there are a few interesting results to discuss. First of all, after using an innovative structural framework to study the distribution scheme in Argentina, I have reached a well-known result in the national literature: Buenos Aires receives significantly less money from the coparticipation system than it should according to its spending needs and local fiscal resources. The key number here is the magnitude of such difference in percentage points: 14.90 %. This difference implies that Buenos Aires should receive 70 % more income from national transfers than what it is currently getting.

However, for any province to receive more transfers, or to be assigned a larger distribution rate, other provinces should see a reduction in theirs. In this regard and on the opposite situation from Buenos Aires, there is Neuquén, which according to the estimations should be almost excluded from this distribution system. The main reason behind this result comes from the high local tax income that Neuquén raises, especially after considering it collected almost 38 % of the national hydrocarbon royalties in 2018. A similar conclusion can be reached when analyzing the case for Santa Cruz. Even though its participation in the national royalties was a little over 15 %, such income represents more than 50 % of its total tax income.

Another interesting result emerges from studying the percentage differences: Some of the poorer provinces are the ones that suffer the largest cuts. This is the case of Santiago del Estero,

Table 10 Comparison of Provinces' Distribution Rates in 2018

Province	Structural DR	Actual Scheme DR	Actual Scheme Diff.	Actual Scheme % Diff.	Porto (2016) DR	Porto (2016) Diff.	Porto (2016) % Diff.
Buenos Aires	35.93 %	21.03 %	14.90 %	70.83 %	35.44 %	0.49 %	1.38 %
Catamarca	1.63 %	2.66 %	-1.03 %	-38.59 %	1.68 %	-0.05 %	-2.69 %
Chaco	3.44 %	4.95 %	-1.51 %	-30.49 %	3.95 %	-0.52 %	-13.04 %
Chubut	1.22 %	1.55 %	-0.33 %	-21.34 %	1.40 %	-0.18 %	-12.70 %
Córdoba	9.25 %	9.15 %	0.09 %	1.03 %	8.16 %	1.09 %	13.38 %
Corrientes	2.87 %	3.70 %	-0.83 %	-22.40 %	3.44 %	-0.57 %	-16.46 %
Entre Ríos	3.30 %	4.76 %	-1.46 %	-30.64 %	3.40 %	-0.10 %	-2.87 %
Formosa	2.45 %	3.56 %	-1.12 %	-31.36 %	2.29 %	0.16 %	6.86 %
Jujuy	2.53 %	2.80 %	-0.27 %	-9.65 %	2.28 %	0.26 %	11.23 %
La Pampa	1.53 %	1.79 %	-0.26 %	-14.54 %	1.52 %	0.01 %	0.84 %
La Rioja	1.55 %	2.01 %	-0.46 %	-22.69 %	1.52 %	0.04 %	2.52 %
Mendoza	4.41 %	4.12 %	0.30 %	7.22 %	4.21 %	0.20 %	4.79 %
Misiones	3.27 %	3.33 %	-0.06 %	-1.71 %	2.19 %	1.08 %	49.10 %
Neuquén	0.01 %	1.71 %	-1.69 %	-99.16 %	0.52 %	-0.50 %	-97.22 %
Río Negro	2.19 %	2.46 %	-0.27 %	-11.00 %	2.56 %	-0.37 %	-14.49 %
Salta	4.27 %	3.90 %	0.37 %	9.49 %	4.37 %	-0.10 %	-2.38 %
San Juan	2.42 %	3.29 %	-0.87 %	-26.34 %	2.27 %	0.15 %	6.82 %
San Luis	1.77 %	2.32 %	-0.55 %	-23.58 %	1.59 %	0.18 %	11.46 %
Santa Cruz	0.71 %	1.52 %	-0.81 %	-53.14 %	1.48 %	-0.77 %	-51.89 %
Santa Fe	7.70 %	9.39 %	-1.69 %	-18.04 %	7.98 %	-0.29 %	-3.60 %
Santiago del Estero	2.46 %	4.10 %	-1.64 %	-40.00 %	3.46 %	-1.00 %	-28.97 %
Tierra del Fuego	0.87 %	1.19 %	-0.32 %	-26.84 %	0.31 %	0.56 %	178.66 %
Tucumán	4.22 %	4.73 %	-0.51 %	-10.77 %	4.00 %	0.22 %	5.54 %

DR: distribution rates. Diff.: differences. %Diff.: percentage differences.
Source: Own estimations and Porto (2016).

Catamarca, Formosa and Chaco. Despite it is clear that for Buenos Aires to increase its relative position, then some other provinces' rate of distribution should decrease, some of this reduction impacts largely on the already less developed jurisdictions. This may be due to a host of factors, but the one I argue is the most prominent is that these provinces spend relatively less in the four services sectors analyzed in this paper. In this regard, Santiago del Estero, Catamarca, Formosa and Chaco are four out of the six provinces that allocated a greater portion of their budgets on social spending, such as: Promotion and Social Assistance, Housing, Drinking Water and Sewerage, etc. (I have explained the reasons not to include these spending categories in the analysis in the Section 3). Thus, it is undoubtedly something to be cautious about when discussing or proposing normative changes to the distribution system. This result is important and should be further analyzed in a future research, because otherwise the less developed provinces could be punished for spending relatively less in the major services when they are actually allocating resources into other more urgent matters.

With respect to the comparison of the estimations with those presented by Porto (2016), there exist some interesting differences between them that are worth mentioning. However, we both arrive to similar values for the distribution rate that Buenos Aires should have. Comparing to the gap between them and the 21.03 % it actually receives, the small difference between our estimators seems irrelevant.

On the other hand, my estimations for Neuquén and Santa Cruz are relatively smaller that those in Porto (2016). For the case of Neuquén, even though Porto (2016) proposes to reduce its distribution rate by 70 %, my estimates goes even to the limit of almost excluding Neuquén from the distribution system given its high local tax income. As for the case of Santa Cruz, Porto (2016) does not modify its distribution rate much, while mine implies a significant reduction. In the exactly opposite situation is Tierra del Fuego, to which Porto (2016) assigns a relatively small distribution rate, while my estimation implies a reduction with respect to the actual levels but not considerably large. A similar case can be seen with Misiones, when Porto (2016) distribution rate is lower than what my estimates predict.

With respect to the argument about poorer provinces, most of the results are quite similar, meaning both estimations show that some large cuts should be done in those provinces' distribution rates.

In addition, it is relevant to contextualize what these rates mean in terms of actual transfers to the provinces. That is why in Table 11 I present the amount in Argentinian pesos as of 2006 that were transferred in 2018 following the actual scheme, together with the transfers the new distribution rates estimated in this paper would have induced. Moreover, these transfers are also displayed in per capita terms.

Table 11 Provinces' Transfers in 2018 with different Distribution Rates

Province	Actual Scheme			Structural Estimation		
	DR	Transfers	Transf. p.c.	DR	Transfers	Transf. p.c.
Buenos Aires	21.03 %	$ 13,218.35	$ 768.67	35.93 %	$ 22,580.87	$ 1,313.12
Catamarca	2.66 %	$ 1,669.55	$ 4,090.51	1.63 %	$ 1,025.29	$ 2,512.04
Chaco	4.95 %	$ 3,109.17	$ 2,633.82	3.44 %	$ 2,161.24	$ 1,830.82
Chubut	1.55 %	$ 974.45	$ 1,628.48	1.22 %	$ 766.47	$ 1,280.90
Córdoba	9.15 %	$ 5,752.74	$ 1,561.57	9.25 %	$ 5,812.11	$ 1,577.69
Corrientes	3.70 %	$ 2,326.81	$ 2,113.20	2.87 %	$ 1,805.54	$ 1,639.79
Entre Ríos	4.76 %	$ 2,988.62	$ 2,196.80	3.30 %	$ 2,073.05	$ 1,523.81
Formosa	3.56 %	$ 2,239.64	$ 3,763.29	2.45 %	$ 1,537.22	$ 2,583.01
Jujuy	2.80 %	$ 1,762.75	$ 2,338.20	2.53 %	$ 1,592.63	$ 2,112.55
La Pampa	1.79 %	$ 1,123.71	$ 3,188.93	1.53 %	$ 960.27	$ 2,725.11
La Rioja	2.01 %	$ 1,262.76	$ 3,295.14	1.55 %	$ 976.30	$ 2,547.63
Mendoza	4.12 %	$ 2,587.28	$ 1,327.29	4.41 %	$ 2,774.21	$ 1,423.19
Misiones	3.33 %	$ 2,090.04	$ 1,694.84	3.27 %	$ 2,054.26	$ 1,665.83
Neuquén	1.71 %	$ 1,073.43	$ 1,659.65	0.01 %	$ 9.03	$ 13.96
Río Negro	2.46 %	$ 1,544.35	$ 2,120.18	2.19 %	$ 1,374.49	$ 1,886.99
Salta	3.90 %	$ 2,450.94	$ 1,765.13	4.27 %	$ 2,683.45	$ 1,932.58
San Juan	3.29 %	$ 2,066.70	$ 2,703.47	2.42 %	$ 1,522.30	$ 1,991.33
San Luis	2.32 %	$ 1,457.87	$ 2,941.46	1.77 %	$ 1,114.09	$ 2,247.83
Santa Cruz	1.52 %	$ 956.83	$ 2,752.72	0.71 %	$ 448.36	$ 1,289.90
Santa Fe	9.39 %	$ 5,902.79	$ 1,695.47	7.70 %	$ 4,837.66	$ 1,389.53
Santiago del Estero	4.10 %	$ 2,574.48	$ 2,686.65	2.46 %	$ 1,544.65	$ 1,611.95
Tierra del Fuego	1.19 %	$ 746.03	$ 4,530.35	0.87 %	$ 545.78	$ 3,314.32
Tucumán	4.73 %	$ 2,971.58	$ 1,796.18	4.22 %	$ 2,651.60	$ 1,602.77

Note: Transfers are expressed in millions of 2006 Argentinian pesos.
Note: Transfers per capita are expressed in 2006 Argentinian pesos.
Source: Own calculation based on DNCFP data .

It can be seen how left back Buenos Aires is with the actual distribution scheme in terms of transfers per capita. With the structural distribution rates estimated its situation improve significantly. On the opposite situation, as expected Neuquén receives almost nothing from this national source. Even though plenty have already been discussed about the impact of these changes for each province, there are some points to consider here: with the actual distribution scheme the provinces receive in average $ 2,402.26 per capita, whereas with the structural DR they would receive in average $ 1,826.81. However, the standard deviation from the actual scheme per capita transfers is $ 907.70, while the estimated scheme has a standard deviation of $ 648.85. Therefore, with the structural DR each province receives in average less national resources per capita but they are all closer together. Arguably, this is a desired property for a new distribution scheme. However, since there are other factors that were considered for the costs estimation, we should not require the per capita transfers differences to completely disappeared either.

Finally, it is worth mentioning that there may exist some endogeneity problems whenever we try to estimate optimal distribution schemes. Mainly, we would like to use variables that cannot be directly modified or affected by the local governments, otherwise they could change their policies and try to receive a larger portion of the transfers. For the model used in this paper the spending by sectors, the salaries and even the tax income can be altered by the local government. However, since the proposed distribution scheme has never been implemented, it can be argued that these variables have not been manipulated by the provinces in order to maximize their distribution rates. If the actual scheme were to be changed, then it is likely to give rise to these endogeneity issues, specially when updating the distribution rates along time.

7. Conclusion

Throughout the paper I have analyzed the current fiscal transfer system in Argentina and propose a new method of distribution of national resources using a structural modeling approach for estimating measures of expenditure needs.

This type of structural framework for fiscal transfers has never been done for Argentina, since most of the empirical analysis in the literature has focus on reduced form estimation. The main advantage of the structural approach is that allows to recover the deep parameters that characterize the preferences and cost functions of the model, instead of just capturing some partial marginal effects.

There are two main empirical results that should be extracted from this paper. The first one is that by using the structural approach, I was able to estimate the amount in pesos that every jurisdiction should be compensated for in order to offer its own basic bundle of services based on its population's expenditure needs. Moreover, a distinction between fixed cost and variable cost can be made, allowing for deeper analysis of each province cost structure on their spending needs.

The second relevant result comes from using these expenditure needs estimations and combining them with fiscal capacity data to determine a new scheme of distribution of national transfers. In this regard, I can replicate a common result in the Argentinian literature on the matter: Buenos Aires should receive a higher rate of the national taxes. Moreover, to be able to finance this I arrive to the result that some of the less developed provinces should resign to a large percentage of their distribution rate. However, the impact this change would have or whether these type of modifications are enforceable, given these provinces rely more heavily on the national transfers to operate, is a matter yet to be studied in the future.

Another relevant topic that was not covered in this paper is how to balance the proposed distribution scheme with a system of situational transfers aimed to aid the provinces when needed. Even though Argentina has the Imbalance Compensation Fund for Provinces created by Law N° 24,130, its funding has remained fixed since 1993 making it almost non-existent in real terms. Thus, this subject constitutes an interesting extension to be added in future studies.

8. References

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9. Appendix

Table A.1: Provinces' average salaries for 2006, 2010, 2014 and 2018

Sector	Average	Standard Deviation	Minimum	Maximum
Administration	1,384.47	360.72	810.65	2,810.77
Security	1,434.53	418.40	821.43	3,048.87
Health Care	1,461.65	465.78	730.66	3,461.83
Education and Culture	1,163.22	256.96	765.54	1,939.24
92 observations				

Note: Values are expressed in 2006 Argentinian pesos.
Source: Own calculation based on the EPH data by INDEC.

Table A.2: Provinces' average salaries for 2006

Sector	Average	Standard Deviation	Minimum	Maximum
Administration	1,197.07	320.21	824.53	2,197.17
Security	1,203.84	367.06	821.43	2,459.78
Health Care	1,262.34	473.52	830.82	2,700.40
Education and Culture	1,013.94	247.39	765.54	1,883.49
23 observations				

Note: Values are expressed in 2006 Argentinian pesos.
Source: Own calculation based on the EPH data by INDEC.

Table A.3: Provinces' average salaries for 2010

Sector	Average	Standard Deviation	Minimum	Maximum
Administration	1,415.58	374.03	877.89	2,624.80
Security	1,371.38	447.82	902.41	2,878.33
Health Care	1,479.13	466.67	730.66	2,679.17
Education and Culture	1,216.05	234.52	928.25	1,879.91
23 observations				

Note: Values are expressed in 2006 Argentinian pesos.
Source: Own calculation based on the EPH data by INDEC.

Table A.4: Provinces' average salaries for 2014

Sector	Average	Standard Deviation	Minimum	Maximum
Administration	1,436.43	393.29	810.65	2,810.77
Security	1,620.08	424.91	1,117.96	3,048.87
Health Care	1,557.66	521.47	773.83	3,461.83
Education and Culture	1,215.62	261.78	912.04	1,939.24
23 observations				

Note: Values are expressed in 2006 Argentinian pesos.
Source: Own calculation based on the EPH data by INDEC.

Table A.5: Provinces' average salaries for 2018

Sector	Average	Standard Deviation	Minimum	Maximum
Administration	1,488.78	298.66	944.10	2,225.09
Security	1,542.83	316.56	995.52	2,621.54
Health Care	1,547.47	352.53	885.03	2,209.53
Education and Culture	1,207.27	239.33	846.22	1,922.73
23 observations				

Note: Values are expressed in 2006 Argentinian pesos.
Source: Own calculation based on the EPH data by INDEC.

Table A.6: Total Variable Costs for all sectors in 2006

Province	Structural Form	Reduced Form
Buenos Aires	$ 35,200,617,178.95	$ 24,584,768,760.51
Catamarca	$ 780,723,470.90	$ 548,355,749.63
Chaco	$ 2,311,627,024.42	$ 1,615,679,765.81
Chubut	$ 1,372,985,901.74	$ 963,894,618.52
Córdoba	$ 8,273,968,678.56	$ 5,784,446,537.48
Corrientes	$ 1,738,766,331.10	$ 1,222,233,537.83
Entre Ríos	$ 2,385,363,496.26	$ 1,670,878,954.86
Formosa	$ 1,120,542,643.80	$ 795,009,251.13
Jujuy	$ 1,142,778,309.04	$ 808,577,585.68
La Pampa	$ 762,811,467.60	$ 542,275,723.46
La Rioja	$ 654,739,517.59	$ 464,527,776.67
Mendoza	$ 3,715,024,793.57	$ 2,625,622,997.69
Misiones	$ 2,098,005,118.09	$ 1,461,412,922.58
Neuquén	$ 1,428,104,049.64	$ 1,018,143,490.81
Río Negro	$ 1,553,873,737.54	$ 1,103,625,308.57
Salta	$ 2,465,807,764.04	$ 1,732,713,425.39
San Juan	$ 1,262,317,739.47	$ 889,079,668.57
San Luis	$ 903,599,969.38	$ 644,679,569.63
Santa Cruz	$ 775,985,533.22	$ 557,641,319.42
Santa Fe	$ 7,650,908,813.81	$ 5,288,024,222.21
Santiago del Estero	$ 1,564,156,547.21	$ 1,103,283,313.24
Tierra del Fuego	$ 535,003,528.65	$ 381,425,970.72
Tucumán	$ 2,945,144,436.73	$ 2,047,154,826.63

Note: Values are expressed in 2006 Argentinian pesos.
Source: Own estimations.

Table A.7: Total Variable Costs for all sectors in 2010

Province	Structural Form	Reduced Form
Buenos Aires	$ 43,749,547,696.30	$ 30,650,977,278.77
Catamarca	$ 871,199,514.52	$ 617,758,665.96
Chaco	$ 2,807,418,430.41	$ 1,970,944,168.37
Chubut	$ 1,642,593,687.82	$ 1,156,093,137.67
Córdoba	$ 9,203,215,057.87	$ 6,419,212,822.25
Corrientes	$ 2,189,562,332.72	$ 1,523,686,925.13
Entre Ríos	$ 2,961,020,150.05	$ 2,058,255,076.42
Formosa	$ 1,299,125,929.98	$ 924,413,790.33
Jujuy	$ 1,612,069,997.90	$ 1,134,952,538.17
La Pampa	$ 995,119,784.13	$ 711,348,441.53
La Rioja	$ 644,494,916.83	$ 456,619,104.78
Mendoza	$ 4,363,889,276.58	$ 3,086,906,765.43
Misiones	$ 2,811,146,363.96	$ 1,966,167,250.12
Neuquén	$ 1,767,337,847.89	$ 1,262,571,686.26
Río Negro	$ 1,806,708,822.94	$ 1,282,486,015.72
Salta	$ 3,113,670,061.11	$ 2,184,801,218.94
San Juan	$ 1,669,998,620.18	$ 1,181,474,463.41
San Luis	$ 1,118,663,945.33	$ 796,809,150.33
Santa Cruz	$ 1,131,481,730.63	$ 802,922,458.68
Santa Fe	$ 8,572,830,742.37	$ 5,984,524,223.39
Santiago del Estero	$ 1,742,923,537.07	$ 1,214,208,465.47
Tierra del Fuego	$ 630,599,552.14	$ 444,755,123.87
Tucumán	$ 3,677,893,550.58	$ 2,552,484,932.96

Note: Values are expressed in 2006 Argentinian pesos.
Source: Own estimations.

Table A.8: Total Variable Costs for all sectors in 2014

Province	Structural Form	Reduced Form
Buenos Aires	$ 44,822,819,641.58	$ 31,648,820,424.16
Catamarca	$ 945,535,840.64	$ 668,244,096.77
Chaco	$ 2,792,488,699.20	$ 1,951,732,410.94
Chubut	$ 1,843,489,290.91	$ 1,309,906,492.12
Córdoba	$ 10,343,400,252.38	$ 7,293,404,344.74
Corrientes	$ 2,451,949,663.05	$ 1,724,413,582.65
Entre Ríos	$ 3,406,681,188.51	$ 2,379,723,253.53
Formosa	$ 1,372,093,997.34	$ 968,680,935.11
Jujuy	$ 1,770,005,227.09	$ 1,253,167,171.97
La Pampa	$ 1,019,629,257.22	$ 721,848,947.20
La Rioja	$ 707,385,063.41	$ 512,663,277.57
Mendoza	$ 4,824,752,895.47	$ 3,414,786,978.40
Misiones	$ 3,007,859,942.42	$ 2,112,817,829.45
Neuquén	$ 1,890,699,124.92	$ 1,344,499,271.72
Río Negro	$ 2,069,828,459.31	$ 1,471,206,088.78
Salta	$ 3,506,011,377.62	$ 2,459,081,916.56
San Juan	$ 1,640,938,995.25	$ 1,167,078,040.35
San Luis	$ 1,362,690,787.00	$ 984,513,782.25
Santa Cruz	$ 1,226,893,150.28	$ 867,943,662.63
Santa Fe	$ 9,498,496,006.74	$ 6,653,373,876.46
Santiago del Estero	$ 1,740,985,750.67	$ 1,225,956,699.90
Tierra del Fuego	$ 790,175,161.22	$ 563,090,423.77
Tucumán	$ 4,376,641,390.80	$ 3,123,092,472.41

Note: Values are expressed in 2006 Argentinian pesos.
Source: Own estimations.

Table A.9: Provinces' Spending Needs in 2018

Province	Spending Needs	RSN
Buenos Aires	$ 49,398,065,572.57	38.05 %
Catamarca	$ 1,640,635,670.33	1.26 %
Chaco	$ 3,592,342,219.50	2.77 %
Chubut	$ 2,560,266,783.44	1.97 %
Córdoba	$ 11,755,331,057.23	9.05 %
Corrientes	$ 2,944,816,943.83	2.27 %
Entre Ríos	$ 4,112,500,555.99	3.17 %
Formosa	$ 2,337,415,749.69	1.80 %
Jujuy	$ 2,538,908,825.85	1.96 %
La Pampa	$ 1,829,029,112.83	1.41 %
La Rioja	$ 1,510,442,962.04	1.16 %
Mendoza	$ 6,152,843,224.95	4.74 %
Misiones	$ 3,725,465,557.58	2.87 %
Neuquén	$ 2,942,976,168.63	2.27 %
Río Negro	$ 2,859,884,694.84	2.20 %
Salta	$ 4,713,011,931.26	3.63 %
San Juan	$ 2,514,493,397.27	1.94 %
San Luis	$ 2,034,013,925.14	1.57 %
Santa Cruz	$ 1,729,180,338.33	1.33 %
Santa Fe	$ 10,156,909,301.56	7.82 %
Santiago del Estero	$ 2,485,196,884.51	1.91 %
Tierra del Fuego	$ 1,329,996,623.53	1.02 %
Tucumán	$ 4,961,365,137.02	3.82 %

RSN: relative spending needs.
Note: Values are expressed in 2006 Argentinian pesos.
Source: Own estimations.

Table A.10: Provinces' Fiscal Capacity in 2018

Province	Fiscal Capacity	RFC
Buenos Aires	$ 17,845,303,104.59	42.49 %
Catamarca	$ 207,971,424.74	0.50 %
Chaco	$ 572,389,030.92	1.36 %
Chubut	$ 1,489,264,580.83	3.55 %
Córdoba	$ 3,633,939,642.84	8.65 %
Corrientes	$ 421,892,873.38	1.00 %
Entre Ríos	$ 1,215,776,374.31	2.89 %
Formosa	$ 189,420,631.69	0.45 %
Jujuy	$ 313,485,557.26	0.75 %
La Pampa	$ 487,226,074.62	1.16 %
La Rioja	$ 146,234,477.61	0.35 %
Mendoza	$ 2,276,381,854.59	5.42 %
Misiones	$ 854,994,946.06	2.04 %
Neuquén	$ 2,930,360,468.66	6.98 %
Río Negro	$ 939,283,903.89	2.24 %
Salta	$ 963,368,947.46	2.29 %
San Juan	$ 387,351,857.01	0.92 %
San Luis	$ 477,268,883.77	1.14 %
Santa Cruz	$ 1,102,676,373.77	2.63 %
Santa Fe	$ 3,397,143,211.43	8.09 %
Santiago del Estero	$ 326,815,967.15	0.78 %
Tierra del Fuego	$ 567,361,783.86	1.35 %
Tucumán	$ 1,256,219,881.99	2.99 %

RFC: relative fiscal capacity.
Note: Values are expressed in 2006 Argentinian pesos.
Source: Own estimations.