Public expenditure smoothing at the subnational level: Evidence from Argentina*

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Abstract

This paper investigates public expenditure smoothing at the subnational level in Argentina. In this country, a tax-sharing regime called Coparticipación Federal de Impuestos regulates intergovernmental transfers. Taxes collected by the National Government are redistributed among provinces using fixed coefficients, related neither to provincial characteristics nor to their policies’ outcomes. In addition, some provinces obtain royalties, which mainly depend on international prices. These two features imply that these two sources of revenues are exogenous for provinces.

First, we develop a theoretical model that enables us to derive a regression equation. Then, using a data set that covers 24 Argentine provinces during the period from 1988 to 2005, we estimate this equation. We find that Argentine provinces spend, depending upon the specifications, between 91 cents and 1.40 pesos per peso of increase in coparticipation transfers, and between 16 and 30 cents for an equivalent increase in royalties. These results are robust to many different specifications.

Then we calibrate the theoretical model to compare its results with the regression outcomes. We find evidence suggesting that provincial public expenditures overreact in response to shocks in coparticipation transfers, while we do observe smoothing of shocks in the case of royalties.

1 Introduction

In many countries, fiscal decentralization is not balanced in terms of tax and expenditure assignments: although central governments collect most taxes, subnational governments (states, regions or provinces) are in charge of an important fraction of total public outlays. As a consequence, these countries are characterized by an important vertical fiscal gap which, most of the times, is solved through intergovernmental transfers.

The study of how subnational governments expend these transfers has been deeply analyzed in the public finance literature, both theoretically and empirically. This paper belongs to both strands

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of this literature. Using a data set that covers 24 Argentine provinces during the period from 1988 to 2005, we investigate whether the degree of public expenditure smoothing observed at the provincial level is consistent with predictions coming from a calibrated, theoretical model of subnational fiscal behavior.

The starting point of our analysis is the following. Argentine provinces receive transfers from the National Government, besides having their own sources of revenues. The institutional framework of these intergovernmental transfers is a tax-sharing regime called Coparticipación Federal de Impuestos. Law 23,548 (1988) that currently regulates this tax-sharing regime specifies the process by which taxes collected by the National Government are reallocated to the provinces. In particular, the law determines, for each province, a fixed participation (or coefficient) in the common pool of taxes to be shared among all jurisdictions. Each province’s coefficient depends neither on their own characteristics nor on policies’ outcomes.

Also, for some jurisdictions, another important source of public income is royalties coming from oil, gas and mineral production. This type of provincial income has been very volatile, and its main source of variation is exogenously determined by changes in international prices. Thus, these two features of the Argentine provincial public finances provide a unique setting for the empirical identification of the degree of expenditure smoothing at the subnational level, because it verifies the key identification assumption that shocks to coparticipation transfers and royalties are truly exogenous with respect to expenditure and revenue provincial decisions.

To start with, we estimate econometrically the stochastic processes that characterize the dynamics of coparticipation transfers, royalties, and provincial GPP. Then, we construct a theoretical model of a representative provincial government that, knowing these stochastic processes, chooses public expenditures and taxes to maximize its intertemporal social welfare, subject to a budget constraint. This model helps us to derive an expression of the optimal public expenditure’s response to changes in the different sources of exogenous provincial public revenues.

Next, we estimate econometrically this theoretical expression. The main results are the following. For each peso of increase in coparticipation transfers, Argentine provinces seem to spend, depending upon the specifications, between 91 cents and 1.40 pesos. But, in the case of royalties, the estimated response lies between 16 and 30 cents. These results are robust to many different specifications.

Finally, we calibrate the theoretical model to construct a hypothetical counterfactual scenario that indicates how much public expenditure smoothing we should expect in Argentine provinces when they face exogenous shocks in coparticipation transfers and royalties. The results can then be compared with regression’s outcomes, to evaluate whether the latter imply a high or low public expenditure smoothing, and whether these deviations, if observed, concern all sources of provincial revenues. The comparisons suggest a low level of provincial public expenditure smoothing in response to shocks in coparticipation transfers, but that this is not the case for royalties.

1.1 Related literature

We are not the first to study local governments’ fiscal responses to revenue shocks in intertemporal models. Holtz-Eakin et al. (1989), Holtz-Eakin and Rosen (1991) and Holtz-Eakin et al. (1993) test empirically to what extend local government consumption decisions are determined by intertemporal considerations. Using aggregate data for US local and state governments, they perform time series estimations to investigate whether spending is determined by current or more permanent income sources. Dahlberg and Johansson (1998) apply the same analysis for the case of Swedish municipalities, while Borge et al. (2001) extend the analysis to local governments in all three scandinavian
countries (Sweden, Denmark and Norway). Both papers use panel estimation techniques. We extend the analyses presented in these papers in two dimensions. First, we show that when we incorporate more structure into the theoretical model employed to motivate the empirical analysis, it is not longer true that a positive partial correlation between current revenues and public expenditures implies that the permanent income hypothesis (or an optimal intertemporal public expenditure behavior) is rejected. Second, Argentine data permits to estimate separately expenditures’ responses to changes in two alternative sources of income: transfers and royalties. Theory predicts that we should expect different responses if the stochastic processes governing the dynamic behavior of each of these types of revenue are not equivalent. Indeed, we verify such theoretical prediction.

Our methodology of contrasting empirical estimations to calibrated theoretical responses of provincial governments’ fiscal policies can also be applied to rigorously characterize whether provincial fiscal policies are “procyclical”. This methodology is absent in much of the empirical literature that has evaluated quantitatively the procyclical hypothesis of subnational governments in developing countries [see Sturzenegger and Werneck (2006), Arena and Revilla (2008), Rodden and Wibbels (2010) and Vegh and Vuletin (2011) among others].

The remainder of the paper is organized as follows. In next section we provide a descriptive analysis of provincial public finances in Argentina. In Section 3, we describe some specific features of coparticipation transfers and royalties. In section 4, we develop a model of intertemporal fiscal behavior for subnational governments. Then, in section 5, we formally test the main hypotheses derived from this model. Next, in Section 6, we compare these empirical estimates with the calibrated theoretical values suggested by the model, and we identify whether there are significant deviations between theory and empirical evidence. After commenting on the possible causes of these deviations, we conclude in section 7. All proofs are shown in the Appendix.

2 Sub-national public finances in Argentina

Argentina is a federal republic, composed of twenty three provinces\(^1\) and the capital Ciudad Autónoma de Buenos Aires (C.A.B.A.).\(^2\) The following table presents the main geographic, demographic and socio-economic, provincial characteristics, for the year 2001.\(^3\) The first three columns display basic geographic and demographic indicators. The fourth and fifth columns show Gross Provincial Product (GPP) expressed as a percent of national GDP, and per capita GPP, in 1991 constant pesos. The last column presents the provincial poverty index: the percent of households with ‘unsatisfied basic needs’.\(^4\)

As we can see, provinces differ in many aspects. On the one hand, there are big provinces (like C.A.B.A., Buenos Aires, Córdoba and Santa Fe) that account for more than 60 percent of the

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\(^1\) Each province is divided in municipalities. But, as their fiscal importance is low, this paper only studies expenditure behavior at the provincial level.

\(^2\) Because it is the country’s capital, C.A.B.A. has some special prerogatives, e.g. its policy is paid by the National Government. Nevertheless, for all issues analyzed in this paper, this city will be assimilated to a province.

\(^3\) As the last national census was performed in 2010, we could have presented more recent socio-economic, demographic data. But, as many observers agree, official socio-economic statistics have not been reliable since 2007. Therefore, we prefer to use 2001 data to show the main economic characteristics of the country.

\(^4\) According to INDEC (1984), a household with ‘unsatisfied basic needs’ is characterized by, at least, one of the following conditions: (i) more than three individuals per room, (ii) inconvenient house, (iii) no WC in the house, (iv) one child (six to twelve years old) that does not attend school, (v) four or more individuals per working person, where the household’s head has not completed the third year of primary school.
country’s population, and generate almost 75 percent of its GDP. On the other hand, there are provinces that have a small population (like Catamarca, La Rioja and Santa Cruz, all with less than 1 percent of total population) or a low participation in national GDP (like Formosa, La Rioja and Santiago del Estero), all with less than 0.75 percent of total GDP). Provinces also strongly differ in their per capita GPP: from $1,598 (Santiago del Estero) to $23,648 (C.A.B.A.). But this characteristic is not correlated with the participation of each provincial production in national GDP. On the other hand, as expected, there is a strong correlation between per capita GPP and provincial poverty index.

<table>
<thead>
<tr>
<th>Province</th>
<th>Area (Sq. km.)</th>
<th>Population (Hab.)</th>
<th>Density (Hab./Sq. km.)</th>
<th>GPP/GDP</th>
<th>Per capita GPP (1991 constant pesos)</th>
<th>Poverty index</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.A.B.A.</td>
<td>203</td>
<td>2,776,138</td>
<td>13,675.56</td>
<td>25.64%</td>
<td>23,648</td>
<td>7.1</td>
</tr>
<tr>
<td>Buenos Aires</td>
<td>307,751</td>
<td>13,827,203</td>
<td>44.93</td>
<td>35.06%</td>
<td>6,492</td>
<td>13.0</td>
</tr>
<tr>
<td>Catamarca</td>
<td>102,602</td>
<td>334,568</td>
<td>3.26</td>
<td>0.71%</td>
<td>5,437</td>
<td>18.4</td>
</tr>
<tr>
<td>Chaco</td>
<td>99,633</td>
<td>984,446</td>
<td>9.88</td>
<td>0.96%</td>
<td>2,494</td>
<td>27.6</td>
</tr>
<tr>
<td>Chubut</td>
<td>224,686</td>
<td>413,237</td>
<td>1.84</td>
<td>1.69%</td>
<td>10,469</td>
<td>13.4</td>
</tr>
<tr>
<td>Córdoba</td>
<td>165,321</td>
<td>3,066,801</td>
<td>18.55</td>
<td>7.49%</td>
<td>6,250</td>
<td>11.1</td>
</tr>
<tr>
<td>Corrientes</td>
<td>88,199</td>
<td>930,991</td>
<td>10.56</td>
<td>1.03%</td>
<td>2,823</td>
<td>24.0</td>
</tr>
<tr>
<td>Entre Ríos</td>
<td>78,781</td>
<td>1,158,147</td>
<td>14.70</td>
<td>1.98%</td>
<td>4,373</td>
<td>14.7</td>
</tr>
<tr>
<td>Formosa</td>
<td>72,066</td>
<td>486,559</td>
<td>6.75</td>
<td>0.33%</td>
<td>1,747</td>
<td>28.0</td>
</tr>
<tr>
<td>Jujuy</td>
<td>53,219</td>
<td>611,888</td>
<td>11.50</td>
<td>0.59%</td>
<td>2,482</td>
<td>26.1</td>
</tr>
<tr>
<td>La Pampa</td>
<td>143,440</td>
<td>299,294</td>
<td>2.09</td>
<td>0.89%</td>
<td>7,599</td>
<td>9.2</td>
</tr>
<tr>
<td>La Rioja</td>
<td>89,680</td>
<td>289,983</td>
<td>3.23</td>
<td>0.72%</td>
<td>6,395</td>
<td>17.4</td>
</tr>
<tr>
<td>Mendoza</td>
<td>148,827</td>
<td>1,579,651</td>
<td>10.61</td>
<td>2.58%</td>
<td>4,180</td>
<td>13.1</td>
</tr>
<tr>
<td>Misiones</td>
<td>29,801</td>
<td>965,522</td>
<td>32.40</td>
<td>1.55%</td>
<td>4,110</td>
<td>23.5</td>
</tr>
<tr>
<td>Neuquén</td>
<td>94,078</td>
<td>474,155</td>
<td>5.04</td>
<td>2.03%</td>
<td>10,943</td>
<td>15.5</td>
</tr>
<tr>
<td>Río Negro</td>
<td>203,013</td>
<td>552,822</td>
<td>2.72</td>
<td>1.40%</td>
<td>6,467</td>
<td>16.1</td>
</tr>
<tr>
<td>Salta</td>
<td>155,488</td>
<td>1,079,051</td>
<td>6.94</td>
<td>1.35%</td>
<td>3,210</td>
<td>27.5</td>
</tr>
<tr>
<td>San Juan</td>
<td>89,651</td>
<td>620,023</td>
<td>6.92</td>
<td>1.00%</td>
<td>4,160</td>
<td>14.3</td>
</tr>
<tr>
<td>San Luis</td>
<td>76,748</td>
<td>367,933</td>
<td>4.79</td>
<td>1.50%</td>
<td>10,450</td>
<td>13.0</td>
</tr>
<tr>
<td>Santa Cruz</td>
<td>243,943</td>
<td>196,958</td>
<td>0.81</td>
<td>1.06%</td>
<td>13,743</td>
<td>10.1</td>
</tr>
<tr>
<td>Santa Fe</td>
<td>133,007</td>
<td>3,000,701</td>
<td>22.56</td>
<td>7.81%</td>
<td>6,668</td>
<td>11.9</td>
</tr>
<tr>
<td>Santiago del Estero</td>
<td>136,651</td>
<td>804,457</td>
<td>5.89</td>
<td>0.50%</td>
<td>1,598</td>
<td>26.2</td>
</tr>
<tr>
<td>Tierra del Fuego</td>
<td>21,571</td>
<td>101,079</td>
<td>4.69</td>
<td>0.45%</td>
<td>11,510</td>
<td>15.5</td>
</tr>
<tr>
<td>Tucumán</td>
<td>22,524</td>
<td>1,338,523</td>
<td>59.43</td>
<td>1.66%</td>
<td>3,186</td>
<td>20.5</td>
</tr>
</tbody>
</table>

Sources: Instituto Geográfico Militar, Instituto Nacional de Estadísticas y Censos, and Dirección Nacional de Coordinación Fiscal con las Provincias.

2.1 Provincial expenditures

The National Government and the provinces have different attributions and prerogatives, either on the expenditure or the revenue side of the budget. Regarding expenditures, Defense and Foreign Affairs are the only areas where, according to the National Constitution, the National Government has an exclusive competence. Then, the Constitution defines a broad area of public services (like
economic infrastructure, social insurance and poverty programs) where the National Government shares responsibilities with provinces, so both levels of government provide these kind of public goods. Finally, primary and secondary education, municipal organization and local services (like police, health and public housing) are areas of the exclusive competence of the provinces.

Participation of provincial public expenditures in the consolidated public sector outlays rose from 40 percent at the beginning of the eighties, to 55 percent in 2005. Figure 1 shows the evolution of aggregate provincial, total and current public expenditures, in millions of 1991 constant pesos, between 1988 and 2005.

Figure 1: Aggregate provincial public expenditures

![Chart showing the evolution of provincial public expenditures from 1986 to 2006.]

Source: Dirección Nacional de Coordinación Fiscal con las Provincias.

During this period, provincial current expenditures represented a significant proportion of total provincial public expenditures. All variables have a positive trend, though they are subject to strong short-term fluctuations. Total expenditures fluctuate more than current expenditures. Still, crisis periods like 1988-90 or 2000-02 show decreases in provincial current public expenditures of around 20 percent.

The information plotted in Figure 1 refers to the aggregate behavior of all provincial governments; but there are differences across jurisdictions. Table 1 presents data on current public expenditures, as a share of total public expenditures, by province.

\[5\] Of course, this high volatility of public expenditures is also observed at the national level.
Table 2: Current public expenditures, as percent of total public expenditures

<table>
<thead>
<tr>
<th>Province</th>
<th>Public consumption</th>
<th>Province</th>
<th>Public consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.A.B.A.</td>
<td>89.0</td>
<td>Mendoza</td>
<td>84.9</td>
</tr>
<tr>
<td>Buenos Aires</td>
<td>88.8</td>
<td>Misiones</td>
<td>77.0</td>
</tr>
<tr>
<td>Catamarca</td>
<td>86.1</td>
<td>Neuquén</td>
<td>71.6</td>
</tr>
<tr>
<td>Chaco</td>
<td>81.9</td>
<td>Rio Negro</td>
<td>80.9</td>
</tr>
<tr>
<td>Chubut</td>
<td>74.5</td>
<td>Salta</td>
<td>84.6</td>
</tr>
<tr>
<td>Córdoba</td>
<td>86.3</td>
<td>San Juan</td>
<td>80.7</td>
</tr>
<tr>
<td>Corrientes</td>
<td>82.4</td>
<td>San Luis</td>
<td>68.3</td>
</tr>
<tr>
<td>Entre Ríos</td>
<td>84.2</td>
<td>Santa Cruz</td>
<td>73.2</td>
</tr>
<tr>
<td>Formosa</td>
<td>78.3</td>
<td>Santa Fe</td>
<td>88.9</td>
</tr>
<tr>
<td>Jujuy</td>
<td>82.9</td>
<td>Santiago del Estero</td>
<td>80.7</td>
</tr>
<tr>
<td>La Pampa</td>
<td>72.3</td>
<td>Tierra del Fuego</td>
<td>74.2</td>
</tr>
<tr>
<td>La Rioja</td>
<td>82.9</td>
<td>Tucumán</td>
<td>85.5</td>
</tr>
</tbody>
</table>

Source: Dirección Nacional de Coordinación Fiscal con las Provincias.

For most provincial governments, average current public expenditures cover 80 percent or more of average total public expenditures, between 1988 and 2005.

How these current expenditures have evolved during this period? Table 3 presents the coefficient of variation (standard deviation over the mean) for these expenditures, by province.

Table 3: Volatility of current public expenditures

<table>
<thead>
<tr>
<th>Province</th>
<th>Volatility</th>
<th>Province</th>
<th>Volatility</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.A.B.A.</td>
<td>0.222</td>
<td>Mendoza</td>
<td>0.253</td>
</tr>
<tr>
<td>Buenos Aires</td>
<td>0.324</td>
<td>Misiones</td>
<td>0.304</td>
</tr>
<tr>
<td>Catamarca</td>
<td>0.195</td>
<td>Neuquén</td>
<td>0.397</td>
</tr>
<tr>
<td>Chaco</td>
<td>0.232</td>
<td>Río Negro</td>
<td>0.216</td>
</tr>
<tr>
<td>Chubut</td>
<td>0.283</td>
<td>Salta</td>
<td>0.146</td>
</tr>
<tr>
<td>Córdoba</td>
<td>0.258</td>
<td>San Juan</td>
<td>0.241</td>
</tr>
<tr>
<td>Corrientes</td>
<td>0.201</td>
<td>San Luis</td>
<td>0.247</td>
</tr>
<tr>
<td>Entre Ríos</td>
<td>0.257</td>
<td>Santa Cruz</td>
<td>0.262</td>
</tr>
<tr>
<td>Formosa</td>
<td>0.224</td>
<td>Santa Fe</td>
<td>0.148</td>
</tr>
<tr>
<td>Jujuy</td>
<td>0.211</td>
<td>Santiago del Estero</td>
<td>0.257</td>
</tr>
<tr>
<td>La Pampa</td>
<td>0.255</td>
<td>Tierra del Fuego</td>
<td>0.199</td>
</tr>
<tr>
<td>La Rioja</td>
<td>0.265</td>
<td>Tucumán</td>
<td>0.452</td>
</tr>
</tbody>
</table>

Source: Dirección Nacional de Coordinación Fiscal con las Provincias.

Despite some differences (e.g. Tucumán’s volatility triples Salta’s figure), most of the provinces present a similar degree of volatility in the evolution of their current public expenditures during the abovementioned period.

2.2 Provincial revenues

Regarding public incomes, Argentina has traditionally a much lower level of decentralization than for expenditures. According to the National Constitution, the National Government has the exclusive
right to tax foreign trade. Indirect taxes are both under the domain of the National and provincial authorities. Finally, only provinces can directly tax their respective populations. Nevertheless, the National Government can constitutionally set direct taxes under ‘special circumstances’.

During the XIX\(^{th}\) and the beginning of the XX\(^{th}\) century, the National Government raised taxes mainly on international trade. Then, as the Great Depression caused a sudden decrease in fiscal revenues (due to the sharp decline in international trade), the National Government started to collect taxes that were previously assigned to the provinces, invoking the ‘special circumstances’ argument abovementioned. In particular, provinces started to ‘delegate’ to the National Government the administration of the most important taxes: personal and corporate income taxes, consumption taxes (VAT, fuels, specific duties) and taxes on wealth.\(^6\) Due to historical reasons,\(^7\) this delegation has persisted until now. But it became more stringent by the end of the eighties because, by Law 23,548 (see bellow), provinces cannot create new taxes.

As a consequence, provincial own sources of tax revenues are very limited. During 1988-2005, the National Government collected, on average, 77 percent of the total tax revenue of the country, whereas provinces were only in charge of the remaining 23 percent. What explains these figures? To start with, provincial taxes are concentrated on a few of them: gross receipts, real state and cars taxes generate, on average, 81.12 percent of provincial fiscal revenues during 1988-2005. In particular, the gross receipts tax explains, on average, 63.66 percent of provincial fiscal revenues. As this is a multiphasic and cumulative tax, tax rates cannot be too high: on average, they amounted to 1.7 percent during the abovementioned period. Moreover, applying stochastic frontier techniques, Di Grescia (2003) shows that, during 1960-2002, provinces were able to collect, on average, 91.18 percent of the potential tax base. Therefore, provinces face difficulties to increase revenues on this tax, and a fortiori, own fiscal revenues.

This gap between expenditures and tax revenues generates an important vertical fiscal imbalance, solved through a system of intergovernmental transfers, and the possibility for provincial governments to borrow domestically and abroad.\(^8\) The system of intergovernmental transfers is based in a tax-sharing regime called Coparticipación Federal de Impuestos.\(^9\) Law 23,548 that currently regulates this tax-sharing regime has been passed in 1988. This law specifies the process by which taxes collected by the National Government are reallocated to the provinces. In particular, the law determines a fixed participation of each province in the common pool of tax resources to be shared among all of them.

For at least six provinces, a third important source of revenue comes from royalties on private sector exploitation of oil, gas and mineral resources. The regime of royalty payments is determined by Law 17,319, enacted in 1967. This law sets up a common approach to all provinces. Under this regime, royalties are collected by the National Government, and then transferred to the original provincial governments, according to a pure devolution criterion. In Section 3, we analyse in more detail specific features of the tax-sharing and royalties regimes.

Since the mid-eighties, coparticipation transfers represented, on average, around 60 percent of

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\(^{6}\) This delegation implied the determination of tax bases and rates by the National Congress, whereas tax collection and other regulatory aspects (e.g. tax enforcement) were undertaken by departments and agencies of the executive branch of the government.

\(^{7}\) When the consequences of the Great Depression began to be attenuated, the II\(^{nd}\) World War created new problems with revenues from international trade.

\(^{8}\) This relatively freedom to borrow allows provinces to run deficits, as a way to smooth public expenditures during the declining phase of the cycle.

\(^{9}\) See Porto (2003) for a detailed description of the historical evolution of the Argentine tax-sharing regime.
total provincial revenues, while provincial own taxes were about 20 percent. Royalties fluctuated from less than 5 percent to 10 percent. Thus, taking all provinces together, these three sources of revenues amounted to almost 90 percent of total income.\footnote{The remaining 10 percent of provincial revenues is composed by (i) transfers called Aportes del Tesoro Nacional (ATNs), distributed by the Interior Ministry, in a discretionary way, and (ii) other transfers from the National Government (see Section 3.1.1.).} Figure 2 below depicts the evolution of provincial revenues, in millions of 1991 constant pesos, between 1988 and 2005.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure2.png}
\caption{Aggregate provincial revenues}
\end{figure}

The information plotted in Figure 2 refers to the aggregate behavior of provincial revenues, but there are significant differences across provinces. Table 4 presents data on average percent revenue composition, by province, between 1983 and 2005.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|c|c|c|}
\hline
Province & Taxes & Transfers & Royalties & Province & Taxes & Transfers & Royalties \\
\hline
C.A.B.A. & 83.2 & 8.0 & 0.0 & Mendoza & 26.3 & 48.5 & 10.0 \\
Buenos Aires & 46.7 & 43.4 & 0.0 & Misiones & 14.1 & 71.9 & 0.9 \\
Catamarca & 6.3 & 83.2 & 0.6 & Neuquén & 13.8 & 29.7 & 41.7 \\
Chaco & 10.6 & 80.5 & 0.0 & Río Negro & 19.2 & 57.8 & 10.7 \\
Chubut & 13.0 & 50.0 & 25.5 & Salta & 14.0 & 67.5 & 4.7 \\
Córdoba & 35.2 & 55.3 & 0.0 & San Juan & 11.6 & 76.8 & 0.1 \\
Corrientes & 10.3 & 80.6 & 0.7 & San Luis & 16.5 & 70.5 & 0.0 \\
Entre Ríos & 23.2 & 65.7 & 1.0 & Santa Cruz & 8.8 & 41.8 & 29.8 \\
Formosa & 4.4 & 86.5 & 1.1 & Santa Fe & 34.3 & 54.1 & 0.0 \\
Jujuy & 8.7 & 69.0 & 0.1 & Santiago del Estero & 9.0 & 81.0 & 0.0 \\
La Pampa & 17.9 & 57.5 & 3.0 & Tierra del Fuego & 15.1 & 46.3 & 19.5 \\
La Rioja & 4.2 & 60.0 & 0.0 & Tucumán & 17.5 & 72.2 & 0.0 \\
\hline
\end{tabular}
\caption{Revenue composition}
\end{table}

Source: Dirección Nacional de Coordinación Fiscal con las Provincias.
Given its special regime as the country’s capital, C.A.B.A. can rely on its own taxes, and thus has a low dependency on national transfers. For the rest of the provinces, the average share of coparticipation transfers is around 60 percent. But for some small and poor provinces (e.g. Catamarca, Corrientes, Formosa and Santiago del Estero) this share rises to more than 80 percent.

As we have already mentioned, for some jurisdictions with significant exploitation of oil, gas and mineral resources in their territories, royalties are also a very significant source of income. As shown in Table 4, above the threshold of 10 percent share in total income, we have six ‘oil jurisdictions’: Chubut, Mendoza, Neuquen, Rio Negro, Santa Cruz and Tierra del Fuego. In particular, for some of them (Chubut, Santa Cruz and Tierra del Fuego), royalties are more important than their own tax revenues.

The level of volatility of each type of revenue by province can be better assessed by the information presented in Table 5. As for Table 3, this table shows the coefficient of variation (standard deviation over the mean) for provincial tax revenues, coparticipation transfers, and royalties (for the six oil jurisdictions).

<table>
<thead>
<tr>
<th>Province</th>
<th>Taxes</th>
<th>Transfers</th>
<th>Royalties</th>
<th>Province</th>
<th>Taxes</th>
<th>Transfers</th>
<th>Royalties</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.A.B.A.</td>
<td>0.254</td>
<td>0.281</td>
<td></td>
<td>Mendoza</td>
<td>0.327</td>
<td>0.279</td>
<td>0.54</td>
</tr>
<tr>
<td>Buenos Aires</td>
<td>0.298</td>
<td>0.313</td>
<td></td>
<td>Misiones</td>
<td>0.384</td>
<td>0.257</td>
<td></td>
</tr>
<tr>
<td>Catamarca</td>
<td>0.578</td>
<td>0.327</td>
<td></td>
<td>Neuquén</td>
<td>0.600</td>
<td>0.244</td>
<td>0.46</td>
</tr>
<tr>
<td>Chaco</td>
<td>0.262</td>
<td>0.297</td>
<td></td>
<td>Río Negro</td>
<td>0.314</td>
<td>0.243</td>
<td>0.46</td>
</tr>
<tr>
<td>Chubut</td>
<td>0.404</td>
<td>0.295</td>
<td>0.72</td>
<td>Salta</td>
<td>0.357</td>
<td>0.274</td>
<td></td>
</tr>
<tr>
<td>Córdoba</td>
<td>0.275</td>
<td>0.309</td>
<td></td>
<td>San Juan</td>
<td>0.401</td>
<td>0.296</td>
<td></td>
</tr>
<tr>
<td>Corrientes</td>
<td>0.229</td>
<td>0.241</td>
<td></td>
<td>San Luis</td>
<td>0.463</td>
<td>0.288</td>
<td></td>
</tr>
<tr>
<td>Entre Ríos</td>
<td>0.293</td>
<td>0.316</td>
<td></td>
<td>Santa Cruz</td>
<td>0.579</td>
<td>0.269</td>
<td>0.46</td>
</tr>
<tr>
<td>Formosa</td>
<td>0.240</td>
<td>0.276</td>
<td></td>
<td>Santa Fe</td>
<td>0.220</td>
<td>0.294</td>
<td></td>
</tr>
<tr>
<td>Jujuy</td>
<td>0.222</td>
<td>0.288</td>
<td></td>
<td>Santiago del Estero</td>
<td>0.395</td>
<td>0.306</td>
<td></td>
</tr>
<tr>
<td>La Pampa</td>
<td>0.250</td>
<td>0.293</td>
<td></td>
<td>Tierra del Fuego</td>
<td>0.490</td>
<td>0.471</td>
<td>0.50</td>
</tr>
<tr>
<td>La Rioja</td>
<td>0.360</td>
<td>0.294</td>
<td></td>
<td>Tucumán</td>
<td>0.320</td>
<td>0.293</td>
<td></td>
</tr>
</tbody>
</table>

Source: Dirección Nacional de Coordinación Fiscal con las Provincias.

Interestingly, we find a high degree of similarity in the level of volatility of coparticipation transfers across provinces. For most jurisdictions, the coefficient of variation associated with this source of revenue fluctuates between 0.24 to 0.31 of its mean level. On the other hand, we find a greater level of disparity across jurisdictions in the volatility indicator associated with provincial tax revenues. It goes from 0.22 for Corrientes to 0.57 for Santa Cruz. These results are not surprising. As we have already mentioned, coparticipation transfers depend basically on national tax revenues. As they are distributed using constant shares, this implies that they must vary according to common shocks affecting national tax revenues (i.e. national GDP fluctuations). Of course, this is not the case for tax revenues which depend also on idiosyncratic shocks affecting provincial tax bases (i.e. GPP fluctuations). Finally, the table shows that the degree of volatility affecting royalties is much higher than for other sources of revenues. But, as with for coparticipation transfers, we observe very similar values across oil jurisdictions, with the exception of Chubut where the coefficient of variation is around 50 percent higher than for the rest of oil provinces.
To conclude this section, observe that Table 2 and 5 show that, in most provinces, current public expenditures fluctuate less than own tax revenues and coparticipation transfers. This suggests some degree of expenditure smoothing, at least with respect to shocks affecting provincial income. Moreover, as for most of the oil jurisdictions the volatility of royalties is higher than the volatility of other sources of revenue, these provinces should face, to some extend, a greater necessity to smooth current public expenditures. The goal of the remainder of the paper is to study theoretically and empirically these issues.

3 Specific features of non-tax provincial revenues

This section analyses two important features of non-tax provincial revenues: (i) their exogeneity, and (ii) the specification of their stochastic processes.

3.1 Exogeneity of coparticipation transfers and royalties

3.1.1 Coparticipation transfers

Based on how coparticipation transfers are institutionally determined, we argue that these transfers can be considered as exogenous in provincial public expenditure decisions. As mentioned in the previous section, Law 23,548 defines the process by which taxes collected by the National Government are reallocated to the provinces. In the following paragraphs, we explain in detail this process.

First, the law determines that, with a few, albeit important, exceptions (e.g. taxes on international trade), almost all taxes collected by the National Government form the common pool of resources called *Masa Coparticipable*. Second, the law specifies a Primary Distribution of the common pool *Masa Coparticipable*: 42.34 percent correspond to the National Government, 54.66 percent go to all provinces, 2 percent are for Buenos Aires (1.5701 percent), Chubut, Neuquén and Santa Cruz (0.1433 percent each),¹¹ and the remaining 1 percent makes a fund to help provinces facing unforeseen contingencies called *Fondo de Aportes del Tesoro Nacional*.¹² Third, the law sets the Secondary Distribution: from the amount of resources to be shared among all provinces (54.66 percent of the common pool *Masa Coparticipable*), each province receives a fixed participation. In Section 4 of this law, the percents (or coefficients) of the Secondary Distribution are set as follows.¹³

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¹¹This 2 percent is aimed at improving the relative level of transfers received by these four provinces in previous tax-sharing regimes.

¹²In fact, this is the fund that finances ATNs distribution mentioned in footnote 10.

¹³To understand how these coefficients were determined, we have to describe the history of the tax-sharing regime before 1988. In 1973, Law 20,221 was enacted. With a stipulated duration of ten years, it was the first law that regulated the tax-sharing regime in an unified way. Law 20,221 specified (Secondary Distribution) coefficients using an explicit formula that weighted provincial population (65 percent), development gap (25 percent) and population dispersion (i.e. inverse of density) (10 percent).

Although a new law should have been passed in 1983, the new democratic government decided to extend Law 20,221’s period of force. But, at the end of 1985, this law expired. As no political concensus emerged at the National Congress to pass a new law, between 1985 and 1987 provinces received national transfers, decided at the Congress level. At the beginning of this period, the pattern of these transfers across provinces was similar than the one observed under Law 20,221. But then, in particular after the legislative elections in 1987 won by the Peronist party, negotiations at the National Congress started to reflect the new distribution of political power of the different provinces, and thus the pattern of transfers changed.

When the National Congress could finally enact Law 23,548, the legal coefficients that appear there cristalized the shares (of the total amount of transfers) obtained by each province during the previous months.
Table 6: Legal coefficients of the Secondary Distribution

<table>
<thead>
<tr>
<th>Province</th>
<th>Percent</th>
<th>Province</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buenos Aires</td>
<td>19.93</td>
<td>Mendoza</td>
<td>4.33</td>
</tr>
<tr>
<td>Catamarca</td>
<td>2.86</td>
<td>Misiones</td>
<td>3.43</td>
</tr>
<tr>
<td>Chaco</td>
<td>5.18</td>
<td>Neuquén</td>
<td>1.54</td>
</tr>
<tr>
<td>Chubut</td>
<td>1.38</td>
<td>Río Negro</td>
<td>2.62</td>
</tr>
<tr>
<td>Córdoba</td>
<td>9.22</td>
<td>Salta</td>
<td>3.98</td>
</tr>
<tr>
<td>Corrientes</td>
<td>3.86</td>
<td>San Juan</td>
<td>3.51</td>
</tr>
<tr>
<td>Entre Ríos</td>
<td>5.07</td>
<td>San Luis</td>
<td>2.37</td>
</tr>
<tr>
<td>Formosa</td>
<td>3.78</td>
<td>Santa Cruz</td>
<td>1.38</td>
</tr>
<tr>
<td>Jujuy</td>
<td>2.95</td>
<td>Santa Fe</td>
<td>9.28</td>
</tr>
<tr>
<td>La Pampa</td>
<td>1.95</td>
<td>Santiago del Estero</td>
<td>4.29</td>
</tr>
<tr>
<td>La Rioja</td>
<td>2.15</td>
<td>Tucumán</td>
<td>4.94</td>
</tr>
</tbody>
</table>

Source: Law 23,548.

In 1990, the *Territorio Nacional de Tierra del Fuego, Antártida Argentina e Islas del Atlántico Sur* became a province. Since then, from the part of the Primary Distribution that used to go to the National Government, 0.7 percent has been destined for this new province. In 1996, the city of Buenos Aires became autonomous. In 2003, Decree 705 fixed C.A.B.A.’s coparticipation coefficient at 1.4 percent, taken again from the National Government’s part.

As stated by Tommasi (2006), several laws regulating the distribution of specific taxes to finance predetermined activities (or provinces) have been enacted. For example, Law 24,699 specifies that, from the income tax collection, and previous to enter the common pool *Masa Coparticipable*, 440 million pesos should be annually retained, to be shared among all provinces. Also, various reforms introduced new types of transfers besides the Coparticipation regime. For example, Law 24,130 stipulates that, previous to the Primary Distribution, 545 million pesos are retained from the the common pool *Masa Coparticipable* to finance (i) a fund to compensate provincial financial disequilibria called *Fondo Compensador de Desequilibrios Provinciales* (85 percent), and (ii) the National Pension System (15 percent). Despite these changes, in most of the cases the sharing of these funds have been made according to the fixed coefficients that appear in Law 23,548.14

The particular features of this tax-sharing regime deserve some comments. First, there is no political agreement or bargaining at the National Congress (or any other political body, like the Commonwealth Grants Commission in Australia) about the Secondary Distribution. Second, the legal coefficients have been held fixed during the period that we analyze. Third, the coefficients are not defined by a formula, like the Canadian *Equalization Program* or the German *Laendersteuern*; so coparticipation coefficients are related neither to observable exogenous (geographic, demographic, socio-economic) provincial characteristics, nor to provincial expenditure plans or outcomes of provin-

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14For example, in 1996, transfers that were distributed in a different way than the one indicated in Law 23,548 represented 32.53 percent of all transfers. But what is more important is the following fact: although the distribution of these transfers have been made according to different coefficients, in almost all of them the coefficients did not depend upon variables under the control of the provincial governments. For example, provinces received 1,318 million pesos to fund (health and education) services that were previously under the control of the National Government but were transferred to the provinces in 1991. The distribution of these funds was made according to the cost of ruling these services. The most important transfer whose distribution among provinces partially depends upon policies under the control of the provincial government is called *Fondo Nacional de la Vivienda* (FONAVI), a fund that helps provinces to build social housing. In 1996, FONAVI amounted to 970.1 million pesos, only 6.7 percent of total transfers to provinces.
cial policies. This is very important because this particular feature of the Coparticipation regime does not generate incentives within provinces to internalize their policies’ outcomes or to manipulate socio-economic indicators in order to obtain more resources from the National Government.

As a consequence of all these issues, coparticipation transfers are closed-end lump-sum grants. They are closed-end, because there are no limits on the absolute amount of resources that a province can receive nor on the percent of its revenues that can proceed from the National Government. They are also unconditional, because the National Government cannot dictate to provinces how to use these funds. Finally, it is clear that coparticipation transfers have neither explicitly nor implicitly matching provisions. All these characteristics eliminate potential considerations for endogeneity (see Section 5.2).

Figures 3 plot the time series behavior for coparticipation transfers, for each province.

Figures 3: Coparticipation transfers, by province, 1988-2005

At first glance, there seems to be a fairly common pattern of evolution across time. This is consistent with the fact that coparticipation transfers are a fixed proportion of the common pool of national taxes Masa Coparticipable. Thus, the temporal evolution of provincial transfers reflect, in great proportion, shocks to the national economy (national business cycle). These temporal

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15 This was the case with the formula used by (the previous) Coparticipation Law 20,221, which expired at the end of 1985.
evolutions do not seem to be influenced by provincial specific forces under control of provincial authorities, undermining our identification assumption.

From the point of view of the empirical work we develop below, what is important is that these provincial shares had been constant during the period under study. Thus, changes in coparticipation transfers would not reflect changes in provincial characteristics or any other provincial decisions during this period. This is crucial when trying to identify the impact of shocks in this source of income on current provincial government expenditures.

3.1.2 Royalties

As we have already mentioned, some provinces obtain important revenues from royalties on private sector exploitation of oil, gas and mineral resources, under the regime of the Law 17,319 (1967). Interestingly, the regime was not modified by the 1994 constitutional amendment, that shifted the property of the mineral resources from the Nation to provinces. Though the domain of oil, gas and mineral sites are now under provincial jurisdictions, the regulation and exploitation of the activity is still under the oversight of the National Government.

The National Government sets, for all provinces, a uniform rate of 12 percent applied to the value of oil, gas and mineral production, evaluated at international prices at the production site. Until 2007, when Law 26,197 was enacted, the National Secretary of Energy was in charge of auditing whether firms reported accurately their production.

Under this regime, provinces have no way to litigate with private firms exploiting oil or gas sites in their jurisdictions. The private sector concessions and contracts are made between these companies and the National Government. Thus, if a given province has a disagreement about the correct application of the regime, it has to litigate with the National Government.

There is another source of endogeneity between public expenditures and royalties: provincial policies can induce changes in oil (or gas) production, modifying in turn royalties. Private conversations with oil firms’ CEOs confirmed to us that these provincial authorities did not have any special policy to attract new oil firms into their province, or to benefit incumbent companies: there have been no special fiscal treatment, public policy favoring the purchase of specific inputs, or special infrastructure. Therefore, we can assert that provincial authorities have no way to influence private sector production. We can conclude that, during the period under analysis, the amount of royalties has been mainly determined by private sector production decisions and international prices. For all practical purposes, these two factors (it is rather obvious in the case of international prices) could not be affected by provincial decisions.

The following figures depict the evolution of royalties, oil prices and provincial production.

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16 Decree 546 (2003) enables provinces to concession new oil and gas areas. Although this could be a potential concern for royalties’ endogeneity, no new concessions were made between 2003 and 2005.
Figures 4: Evolution of royalties, oil prices and provincial production
Observe that, from 1998 onwards, Neuquén, Santa Cruz (the two most productive provinces) and Tierra del Fuego have decreased oil production, but royalties have nevertheless sharply increased, following the evolution of international prices. Therefore, the evolution of royalties seems to depend more upon the evolution of international prices than from other issues. This feature of the regime is very important in supporting the assumption that changes in royalties can be considered as exogenous shocks affecting provincial revenues.

3.2 The stochastic processes of coparticipation transfers and royalties

A final piece of descriptive analysis that will be useful to consider in the following sections is the stochastic processes governing the dynamics of the different sources of provincial revenues. As we have already mentioned, and will be clear in the following theoretical analysis, the features of these stochastic processes are relevant to determine the magnitude of the response of provincial public expenditures to exogenous shocks in income. Tables 7 describe the estimation of autoregressive (AR) equations for coparticipation transfers, royalties and provincial GPP (which determines provincial taxes), using annual data for the period 1983 – 2005, aggregating (or averaging out) across all provincial jurisdictions (21 year observations). We estimate specifications with 1, 2 and 3 lags. We compute the Akaike Information Criterion (AIC), the Bayesian Information Criterion (BIC), and the Breusch-Godfrey serial correlation (B-G SC) test. First, we present the results for royalties.

Table 7.1: Estimation of autoregressive equation for the first difference in royalties

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>39,098.24***</td>
<td>22,857.6***</td>
<td>9,536.91***</td>
</tr>
<tr>
<td>1 lag</td>
<td>-0.0248781</td>
<td>0.0044491</td>
<td>-0.0983048</td>
</tr>
<tr>
<td>2 lags</td>
<td>0.3630517</td>
<td>0.4054636**</td>
<td></td>
</tr>
<tr>
<td>3 lags</td>
<td></td>
<td>0.1551276</td>
<td></td>
</tr>
<tr>
<td>AIC</td>
<td>569.2944</td>
<td>542.0417</td>
<td>515.3864</td>
</tr>
<tr>
<td>BIC</td>
<td>571.3834</td>
<td>545.0289</td>
<td>519.1642</td>
</tr>
<tr>
<td>B-G</td>
<td>0.3176</td>
<td>0.2335</td>
<td>0.0346***</td>
</tr>
</tbody>
</table>

* Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level.

According to B-G statistic, the specifications with 1 and 2 lags show no serial correlation of errors. Then, upon evaluation of the significance of the AR coefficients, it seems that royalties’ first difference does not depend upon lagged differences. Hence, we conclude that royalties’ level follows a random walk with a drift (constant). Next we show the results for coparticipation transfers.

17 Of course, the dynamics of royalties is the combination of the dynamic of hydrocarbon prices and production. As argued, the former is exogenous and determined by global markets. The exact dynamic behavior of oil prices have been subject to different empirical findings [Cuddington (1992), Pindyck (1999)(2004), Schwartz and Smith (2000)]. However, in general researchers agree that there is a short-term dynamic (cycles) that is completely different from the long-run trend. Given the time frame of our paper, we are probably capturing more the short-run dynamic than the long-run one.
Table 7.2: Estimation of autoregressive equation for the first difference in coparticipation transfers

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>390,212.5***</td>
<td>367,129.9***</td>
<td>513,593.4***</td>
</tr>
<tr>
<td>1 lag</td>
<td>0.2379936</td>
<td>0.3448977*</td>
<td>0.1914725</td>
</tr>
<tr>
<td>2 lags</td>
<td>-0.4900891**</td>
<td>-0.430774*</td>
<td></td>
</tr>
<tr>
<td>3 lags</td>
<td></td>
<td></td>
<td>-0.4184513</td>
</tr>
<tr>
<td>AIC</td>
<td>651.6615</td>
<td>615.0153</td>
<td>584.25</td>
</tr>
<tr>
<td>BIC</td>
<td>653.7505</td>
<td>618.0025</td>
<td>588.0278</td>
</tr>
<tr>
<td>B-G</td>
<td>0.0123***</td>
<td>0.2856</td>
<td>0.1432</td>
</tr>
</tbody>
</table>

* Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level.

Based on the information conveyed by the B-G statistic, specifications with 2 and 3 lags show no serial correlation of errors. Despite the fact that, according to AIC and BIC the third specification should be kept, looking at the coefficient’s statistical significance, it seems that the best specification for the dynamics of coparticipation transfers is the one with two lagged autoregressive terms and a drift. This specification recognizes that changes in these resources obey a long term growth pattern, but that they are also subject to cyclical fluctuations. Finally we present the estimation of the first difference in GPP.

Table 7.3: Estimation of autoregressive equation for the first difference in GPP

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>3,529,088***</td>
<td>4,931,211***</td>
<td>4,917,576***</td>
</tr>
<tr>
<td>1 lag</td>
<td>0.5063461**</td>
<td>0.6692774***</td>
<td>0.6405116**</td>
</tr>
<tr>
<td>2 lags</td>
<td>-0.3281295</td>
<td></td>
<td>-0.227927</td>
</tr>
<tr>
<td>3 lags</td>
<td></td>
<td></td>
<td>-0.1948218</td>
</tr>
<tr>
<td>AIC</td>
<td>751.6724</td>
<td>716.1502</td>
<td>681.7761</td>
</tr>
<tr>
<td>BIC</td>
<td>753.7615</td>
<td>719.1374</td>
<td>685.5539</td>
</tr>
<tr>
<td>B-G</td>
<td>0.1315</td>
<td>0.7696</td>
<td>0.9245</td>
</tr>
</tbody>
</table>

* Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level.

In all specifications, the B-G test indicates absence of serial correlation. According to AIC, BIC and the significance of the coefficients, the equation that best describes the dynamic of this provincial GPP is the one with one lagged autoregressive term.

4 Theoretical Framework

The goal of this section is to develop a simple model that could provide two key inputs for the empirical analysis. First, we want to derive an specification for the regression analysis that extends the basic intertemporal smoothing-type behavior of rational agents (in our case, a local government) to include the stochastic processes affecting the different sources of provincial revenues, i.e. coparticipation transfers and royalties. As we will see, the parameters describing these processes will have consequences in terms of how shocks in those type of public revenues affect expected wealth, and
thus public expenditures. Second, the theoretical model can also be used to construct a benchmark, indicating how much public expenditure smoothing we should expect in an ideal setting where provincial
governments maximize social welfare, and have all information about the stochastic processes
governing their revenues. The theoretical results obtained in this benchmark can then be compared
with the regression output, to evaluate how much actual behavior deviates from theory.

The model builds up on Holtz-Eakin et al. (1993). In order to maximize social welfare, the
representative provincial government chooses the level of public expenditure and provincial taxes
subject to an intertemporal budget constraint. On the revenue side of the budget we have, in addition
to local taxes and bonds (debt), transfers received from the federal government (coparticipation
transfers) and revenues associated with a given participation on private-sector production of oil
(royalties). Following the institutional setting described in the previous sections, we assume that
royalties are mainly determined by international prices, within a national regime that cannot be
modified by provincial authorities. Thus, while local taxes and deficit financing are endogenously
decided by the provincial government, coparticipation transfers and royalties are exogenous sources
of revenues. We also assume that aggregate, private sector, provincial income is also exogenously
determined.\footnote{This implies that we also assume that private income is not affected by provincial fiscal policies. Theoretically,
it can be supported by the assumption of a small open economy where the real interest rate is given, and cannot be
affected by provincial fiscal policies. This, in turn, implies that labor supply does not change.

One can think of another channel through which provincial fiscal policies can affect private sector output, namely
the provision of public inputs (e.g. infrastructure) that increase private sector’s productivity. But, according to the
data presented in Section 2, provincial public investment is a very low fraction of total provincial, public expenditures.

Finally, given that we are dealing with an intertemporal equilibrium model, we also rule out keynesian-type effects
of provincial fiscal policies on local aggregate demand and private sector income.}

The model assumes that the choice variables of the provincial government are contingent on the
observed shocks to coparticipation transfers and royalties. For this purpose, we define \( z^s \) as the
history of shocks at date \( s \). The provincial government solves the following problem

\[
\max_{\{C_s(z^s), G_s(z^s), T_s(z^s), B_{s+1}(z^s)\}} \mathbb{E}_t \left[ \sum_{s=t}^{\infty} \beta^{s-t} W[C_s(z^s), G_s(z^s)] \right]
\]

(1)

s.t.

\[
G_s(z^s) = Y_s(z^s) - T_s(z^s) \quad \forall s \geq t, \forall z^s
\]

(2)

\[
G_s(z^s) + B_{s+1}(z^s) = T_s(z^s) + TR_s(z^s) + R_s(z^s) + (1+\tau)B_s(z^{s-1}) \quad \forall s \geq t, \forall z^s
\]

(3)

where (1) is the expected intertemporal social welfare criterion: it is the present value, discounted
at the social rate of time preference \( \beta \), of the stream of within period social welfare \( W[\cdot] \), which
we assume to be concave and separable in aggregate private consumption \( C_s \) and in current public
expenditures \( G_s \). We denote by \( Y_s \) the aggregate private-sector disposable income (net of national
taxes), by \( T_s \) provincial taxes, by \( TR_s \) coparticipation transfers, by \( R_s \) royalties, and by \( B_s(z^{s-1}) \) one
unit of provincial assets bought at date \( (s-1) \), that pay \( (1+\tau) \) at date \( s \). Expression (2) represents
the private-sector budget constraint, while (3) denotes the provincial budget constraint.

We assume that the representative province is a small open economy, with perfect capital mobility.
Hence, the provincial interest rate is equal to the international interest rate \( r \), which is constant both
across time and states of nature. Replacing (2) in (3), we get the following aggregate resource
constraint for the local economy,
\[ G_s(z^s) + C_s(z^s) + B_{s+1}(z^s) = Y_s(z^s) + TR_s(z^s) + R_s(z^s) + (1 + r)B_s(z^{s-1}) \] (4)

As we have already mentioned, a key ingredient of the model is the information regarding the stochastic processes governing the different sources of provincial public revenue. As we will see below, this is important to calculate expected provincial wealth, which in turn will affect decisions regarding provincial expenditures. We assume that the provincial government knows these stochastic processes.

With respect to royalties, taking into account what has been shown in Figures 4 and in Table 7.1, we assume that the dynamic of these revenues are characterized by the following stochastic process

\[ R_s = \rho R_{s-1} + (1 - \rho)\mu + \epsilon_s. \] (5)

Equation (5) describes a mean reverting process with \( \rho \in [0, 1] \), where \( \epsilon_s \) is a white noise shock affecting the level of royalties, and \( \mu \) is a long-term value to what royalties converge. Notice that if \( \rho = 1 \), equation (5) would imply that royalties follow a random walk where innovations \( \epsilon_s \) have a permanent effect on the level this source of income, as suggested by the estimations shown in Table 7.1.

With regards to coparticipation transfers, we are in the presence of provincial revenues that, in contrast to royalties, they tend to grow in the long run, as shown in Figure 2. This is due to the country’s economic growth: coparticipation transfers depend on national taxes, which in turn depend on national GDP. Still, beyond this long term trend, it is generally the case that provincial GPP and national GDP fluctuate due to business cycles reasons. Thus, taking into account these considerations and the evidence we showed in Table 7.2, we assume that the short and long-term dynamics of coparticipation transfers is given by the following law of movement,

\[ (\Delta TR_s - \phi) = \rho_1^{TR} (\Delta TR_{s-1} - \phi) + \rho_2^{TR} (\Delta TR_{s-2} - \phi) + \xi_s, \] (6)

where \( \phi \) is a parameter determining the long-run value for changes in coparticipation transfers, and \( \xi_s \) represents a white noise shock affecting the dynamics of this source of revenues. Clearly, compared to shocks to royalties, these perturbations in coparticipation transfers would modify expected wealth in a much significant way because they also affect the long term change in this variable. In addition, the impact on expected provincial wealth of the various shocks will also depend on how permanent are these innovations which, in turn, depends on the magnitude of the autoregressive coefficients \( \rho_1^{TR} \) and \( \rho_2^{TR} \).

Finally, for the case of provincial GPP, the postulated stochastic process has the following form,

\[ (\Delta Y_s - \gamma) = \rho_1^{Y} (\Delta Y_{s-1} - \gamma) + \omega_s. \] (7)

In this case, and consistent with the estimation shown in Table 7.3, we assume a mean reverting process for changes in provincial GPP, with \( \rho_1^{Y} \in [0, 1] \) and \( \omega_s \) representing white noise shocks affecting these changes.

Using (1) and (4), the provincial government’s problem is as follows,

\[
\max_{\{C_s,G_s,B_{s+1},\lambda_s\}_{s=t}^{\infty}} E_t \sum_{s=t}^{\infty} \{\beta^{s-t} W[C_s(z^s), G_s(z^s)] + \lambda_s(z^s)[Y_s(z^s) + TR_s(z^s)]
\] (8)
\[ +R_s(z^s) + (1 + r)B_s(z^{s-1}) - G_s(z^s) - C_s(z^s) - B_{s+1}(z^s)]\]

where \( B_t \) is given, and \( \lambda_s(s) \) is the Lagrange multiplier associated with the intertemporal budget constraint.

We assume that innovations in royalties, provincial GPP and coparticipation transfers occur at the beginning of each period. So, at time \( s, \epsilon_s, \xi_s \) and \( v_s \) are known numbers. Let’s define by \( F(z^s) \) the cumulative distribution function of history \( z^s \).19 With these assumptions, the first-order conditions corresponding to problem (8) are:

\[ \beta^{s-t}W_C(C_s)dF(z^s) = \lambda_s(z^s) \quad \forall s \geq t, \forall z^s \quad FOC(C) \]

\[ \beta^{s-t}W_C(G_s)dF(z^s) = \lambda_s(z^s) \quad \forall s \geq t, \forall z^s \quad FOC(G) \]

\[ -\lambda_s + \int_{z_{s+1}|z^s} \left[ \lambda_{s+1}(z^s, z_{s+1})(1 + r) \right] = 0 \quad \forall s \geq t, \forall z^s \quad FOC(B) \]

and the transversality condition is:

\[ \lim_{s \to \infty} E_t \left[ \frac{B_s}{(1 + r)^{s-t}} \right] = 0 \quad (9) \]

To simplify the derivation of an analytical solution that could be used to motivate the empirical analysis, we assume that the social welfare function \( W[.] \) adopts the following functional specification20

\[ W[C_s, G_s] = \left( C_s - \frac{a}{2} C_s^2 \right) + \left( \frac{a\theta}{2} G_s^2 \right), \]

where \( a \) is a positive but a small enough number, so that welfare is strictly increasing in a neighborhood of the solution. More important, \( \theta \geq 0 \) is a parameter that captures the degree of substitution, in welfare terms, between \( C_s \) and \( G_s \). Specifically, the marginal rate of substitution between public expenditures and private consumption decreases with \( \theta \). Therefore, different values of this parameter characterize different types of government’s expenditure behavior. With these assumptions, we can re-write the first-order conditions as follows,21

\[ C_s = \theta G_s \quad (10) \]

\[ a\theta \left( G_s - E_s[G_{s+1}] \right) = 1 - \beta (1 + r). \quad (11) \]

Expression (10) describes the intra-period optimal allocation between private consumption and current public expenditures. As expected, the lower \( \theta \) is, the lower is the ratio of private consumption to current public expenditures at the optimum.

The Euler equation (11) describes the optimal expected change for current public expenditures (and, given (10), also for private consumption). Given the assumed social welfare criterion (where the intertemporal elasticity of substitution equals 1), and depending upon the relationship between

---

19 Determined by innovations \( (\epsilon_s, \xi_s, \omega_s) \).

20 Alternatively, we could have used the more conventional CRRA specification. But in this case, we could not obtain a close-form solution.

21 From now on, we omit the dependence on the history of shocks \( z^s \) to simplify notation.
interest rate vis-à-vis the discount rate $\beta$, we can have an increasing, constant or decreasing expected path. If $\beta(1 + r)$ is not too different from 1, the solution implies a fairly constant (or at most, smoothly increasing if $(1 + r) > \beta$) level of public expenditures. Thus, theory suggest that the provincial government should avoid temporary changes in revenues to have any major impact on public expenditures. If we assume that $\beta(1 + r) = 1$, we obtain

$$ G_s = E_s(G_{s+1}), $$

which suggests that provincial current public expenditures $G$ follow a martingale, a modified version of Hall’s (1978) result.

Iterating on (4) and using (9), we can obtain the intertemporal resource constraint in expectations terms,

$$ E_t[\sum_{s=t}^{\infty} \frac{(C_s + G_s)}{(1 + r)^{s-t}}] = E_t[\sum_{s=t}^{\infty} \frac{(Y_s + TR_s + R_s)}{(1 + r)^{s-t}}] + (1 + r)B_t. $$

Replacing (10) in (13) we get,

$$ (1 + \theta) E_t[\sum_{s=t}^{\infty} \frac{G_s}{(1 + r)^{s-t}}] = E_t[\sum_{s=t}^{\infty} \frac{(Y_s + TR_s + R_s)}{(1 + r)^{s-t}}] + (1 + r)B_t. $$

Now, using the law of iterative expectations and replacing in the left hand side of (14), we obtain,

$$ (1 + \theta) E_t[\sum_{s=t}^{\infty} \frac{G_s}{(1 + r)^{s-t}}] = (1 + \theta) G_t \frac{1 + r}{r}. $$

Calling the lhs of (14) the expected level of wealth, $E_t(W_t)$, we find,

$$ G_t = \frac{r}{1 + r} \frac{1}{1 + \theta} E_t(W_t). $$

Expression (16) is the typical condition derived in intertemporal consumption models, where consumption is a function of total wealth and the propensity to consume out of wealth is closed to the real interest rate. This is what we get above, with the added feature that wealth has to be allocated both to private consumption and current public expenditures, depending on the parameter $\theta$.

Going one step further than Holtz-Eakin et al. (1993), we can now use (16) and the laws of movement (5), (6), (7) to obtain an explicit analytical solution for the level of provincial current public expenditures. We provide the details of the derivation in the Appendix. The final expression for the change in current public expenditures $\Delta G_t$ is

$$ \Delta G_t = \frac{1}{1 + \theta} \left\{ \frac{1 + r}{(1 + r - \rho_1^Y)} \Delta Y_t - \frac{\rho_1^Y}{(1 + r - \rho_1^Y)} \Delta Y_{t-1} \right. $$

$$ \left. + \frac{(1 + r)^2}{(1 + r - \rho_1^{TR})(1 + r) - \rho_1^{TR}} \Delta TR_t - \frac{\rho_2^{TR}}{(1 + r - \rho_1^{TR})(1 + r) - \rho_2^{TR}} \Delta TR_{t-1} \right. $$

$$ \left. - \frac{\rho_2^{TR}(1 + r)}{(1 + r - \rho_1^{TR})(1 + r) - \rho_2^{TR}} \Delta TR_{t-2} + \frac{r}{(1 + r)} \Delta R_t + r \Delta B_t \right\}, $$

20
where $\Delta Y_t$, $\Delta Y_{t-1}$, denote current and one period lagged changes in provincial private sector income; $\Delta TR_t,\Delta TR_{t-1},\Delta TR_{t-2}$ indicate current, one and two-period lagged changes in coparticipation transfers; $\Delta R_t$ represents current changes in royalty revenues, and $\Delta B_t$ means one-period lagged change in the stock of public bonds (debt). We finally obtain that the change of current public expenditures is a function of all known variables at time $t$, even when we are working with a model where consumption depends on long term perceived wealth. Of course, the key assumption is that the government knows the parameters determining the law of movement of its various sources of income.

Notice that the optimal reaction of public consumption expenditures to changes in coparticipation transfers is larger than for changes in royalties, even if we were to have the same persistence parameters (say, $\rho = \rho_1^{TR} = \rho_2^{TR}$). As anticipated above, this reflects the fact that shocks to the first type of revenues affects its change over time, so they have a much larger impact on perceived wealth. In addition, the optimal response depends on how permanent or not are the shocks, as defined by the value of the autoregressive parameters. For example, in the case of the coefficient of royalties, if the shock were to be temporary ($\rho$ close to zero) then the optimal response of total current, private and public expenditure to a shock in this type of revenue is very small and close to the interest rate $(\frac{\rho}{1+\rho})$; while if the shock is permanent ($\rho$ close to one) the coefficient is much larger and close to one. This is exactly the usual prediction of the permanent income theory. The same happens for the other sources of revenues. The economic intuition behind this classical result is clear: a positive shock today is a signal of higher resources in the future and this has a significant effect in terms of raising the expected level of wealth, which affects expenditure decisions. Thus, the theory suggest that the predicted response of expenditures to the various sources of government revenues should differ, as long as we observe differences in the stochastic processes governing the time profile of the various sources of provincial revenues.

5 Econometric evidence on expenditure smoothing

5.1 Basic estimation

In this section, we present the econometric results. We estimate the following empirical specification of the theoretical expression (17)

$$
\Delta G_{t,i} = \text{cons} + \alpha_1 \Delta Y_{t,i} + \alpha_2 \Delta Y_{t-1,i} + \beta_1 \Delta TR_{t,i} + \beta_2 \Delta TR_{t-1,i} + \beta_3 \Delta TR_{t-2,i} + \\
+ \delta_1 \Delta R_{t,i} + \Phi_1 \Delta B_{t,i} + \epsilon_i + d_t + \nu_{t,i}.
$$

The data set we use covers 24 Argentine provinces during the period from 1988 (the date when Law 23,548 was enacted) to 2005. The dependent variable is changes in provincial current public expenditures $\Delta G_{t,i}$. Explanatory variables include: (i) change in provincial GPP ($\Delta Y_t$), (ii) change in coparticipation transfers ($\Delta TR_t$), (iii) change in royalties ($\Delta R_t$), and (iv) change in previous period stock of public bonds/debt ($\Delta B_t$). Besides these variables, we include fixed effects by province ($\epsilon_i$) and time dummies ($d_t$).

---

22 The importance of identifying shocks that affects the medium-long term dynamics of income (shocks to “trend growth”) has been recently emphasized by Aguiar and Gopinath (2007), as a way to explain consumption volatility that exceeds income volatility, and “sudden stops” in capital inflows in emerging economies.

23 Recall, from (10), that $G_s + G_s = (1 + \theta)G_s$.

24 All these variables used in the regressions are stationary in their first differences.
The estimations will be run using panel fixed-effects methods, in particular feasible generalized least square estimations (FGLS). As we indicated earlier, the whole purpose of the econometric exercise is to obtain a precise and unbiased estimate of the reaction of current public expenditures to changes in coparticipation transfers and royalties (coefficients $\beta_1$ and $\delta_1$ respectively). We have argued in Section 3 that the institutional set up within which these provincial revenues are determined assures that they are exogenous with respect to provinces’ characteristics and their fiscal policies. Adopting the Dahlberg et al.’s (2008) framework for analyzing potential endogenous biases when estimating the effect of central government grants on local government spending, we check for the following problems:

(i) If the grant system is designed in negotiations between regional representatives at the congress, the political strength in bargaining plus preferences for local spending affect transfers’ distribution among regions. If this were the case in our context, statistical correlations between coparticipation transfers (or royalties) and expenditures may reflect the role of these unobserved characteristics, rather than the effect of these type of revenues themselves. With respect to the Secondary Distribution of coparticipation transfers, it is automatically determined by fixed coefficients that have remained constant since the beginning of the regime, and during all the period under analysis. In other words, no bargain between provinces could have affected the distribution of these transfers after 1988. Hence, no political channel like the one analyzed by Knight (2002) can create an endogeneity problem here. One could argue that some socio-economic and political, observable and non-observable, provincial characteristics that had an influence during the negotiations of the new coparticipation regime in the last months of 1987 could also affect provincial public expenditures decisions later on. If this were the case, it could be a potential source of endogeneity that can bias the estimations. Assuming that these factors were constant during 1988 - 2005, the panel estimation using provincial fixed effects controls for them. On the other hand, royalties have depended on a rate of 12 percent that was common to all provinces, and kept fixed during the whole period.

(ii) Even in the absence of negotiations political variables might matter because, as stated by Johansson (2003), central politicians may have preferences for economic or political characteristics of specific provinces, and thus can strategically taylor the design of intergovernmental transfers to target them to these particular provinces. Therefore, these provincial characteristics also indirectly affect expenditure patterns, inducing an endogenous bias in the estimation. This bias cannot appear in our analysis because the National Government could not modify the resource allocation across provinces. Similarly, the regime that determines royalties was defined by a national law that prohibited the National Government to fiscally discriminate between different provinces. These observations rule out the abovementioned potential concern for endogeneity.

(iii) Local, socio-economic observable characteristics may influence the way provincial expenditures are determined, and also how coparticipation transfers are distributed. Again, this potential endogeneity bias is absent for coparticipation transfers because their distribution does not depend on observable provincial characteristics (as was the case with the previous coparticipation regime defined by Law 20,221). Any provincial characteristic that, as a remaining effect of Law 20,221, could still be implicitly associated with the distribution of coparticipation transfers (e.g. provincial density) is controled for by the provincial fixed effect. Regarding royalties, the regime stipulated that they were distributed across producer provinces depending on the production value at the exploitation site. We have already mentioned that international prices, a very important determinant of this value, are independent of provincial characteristics, or out of provincial control. The other determinant of royalties is oil (or gas) production level. In principle, such variable could depend not only on the geological features of each site, but also on outcomes of provincial policies, like infrastructure
and any other public good that could affect oil firms’ decision to initiate the exploitation of a given site, or its production process. The latter define the “business climate” in a given province, and may also be correlated with public expenditures. The empirical relevance of this potential source of endogeneity is nevertheless not significant in our case. As stated by oil firms, actual decisions to open a production site depend mainly on geological variables, as well as on technological developments. Both of them are not under control of provincial authorities. Any remaining provincial characteristic that could affect hydrocarbon production, and which remained constant during the period 1988 - 2005, will be controled by the provincial fixed effect.

(iv) Unobserved characteristics and shocks, specially those that are temporal, and that affect both the distribution of transfers and expenditures decisions by provinces, could consist on alternative potential causes for endogeneity. In this case, it is clear that any aggregate shock that affects all provinces at the same time (e.g. change in the international interest rate) is controlled for by the time dummy. Regarding coparticipation transfers, we could think of temporary shocks that, affecting the GPP of a given province, would also have an impact on the national GDP, on the amount of taxes collected by the National Government, and on transfers. For example, this may happen if this particular province’s GPP is an important fraction of the national GDP. This shock could have an independent and direct effect on government spending in this particular, affected province, inducing a bias in the estimation. As we will see below, the way we propose to deal with this potential source of endogeneity is to run the regressions taking away the largest provinces.

Beyond the above mentioned problems arising from potential endogeneity biases, estimation results could also be affected by other econometric problems that typically arise in panel data estimations. In particular, we worry about three specific issues: (a) heteroskedastic pattern across sectional observations (by province), (b) correlation of errors across panels, and (c) autocorrelation. There is a strong presumption that these potential problems are indeed relevant here, for the following reasons. First, the dependent variable is the absolute change in provincial current public expenditures. Clearly, this change will be larger for larger provinces (like Buenos Aires) compared to small ones (like Formosa). Thus its variance changes across provincial observations, being larger for larger provinces. Second, as the main determinants of both transfers and royalties revenues are common shocks associated with the national business cycle and oil prices, respectively, the error term in the regression will be correlated across panel observations. Finally, by definition, expenditure smoothing behavior would imply a certain level of autocorrelation of the error term.

Table 9 below presents the results of the basic estimations. In each column, we show the results when we incorporate corrections for the abovementioned problems. The first column corrects for heteroskedastic errors. The second column adds the possibility that there could be correlation of errors across provinces. In the last two columns, we introduce the possibility that the error term follows an AR(1) process, which could be common to all panel observations (column 3) or either specific for each province (column 4).
Table 8: Estimation of changes in provincial current public expenditures

<table>
<thead>
<tr>
<th>Variables</th>
<th>Heteroskedastic errors</th>
<th>Heteroskedastic errors and correlated panel</th>
<th>Heteroskedastic errors, correlated panel and autocorrelation</th>
<th>Heteroskedastic errors, correlated panel and autocorrelation (panel specific)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\Delta Y_t)</td>
<td>0.007 ((-1.19))</td>
<td>0.011 ((7.18)^{***})</td>
<td>0.016 ((11.51)^{***})</td>
<td>0.013 ((6.96)^{***})</td>
</tr>
<tr>
<td>(\Delta Y_{t-1})</td>
<td>0.006 ((1.04))</td>
<td>0.004 ((2.46)^{***})</td>
<td>0.001 ((-0.75))</td>
<td>0.003 ((-1.62))</td>
</tr>
<tr>
<td>(\Delta TR_t)</td>
<td>0.975 ((18.52)^{***})</td>
<td>1.333 ((64.46)^{***})</td>
<td>1.40 ((68.53)^{***})</td>
<td>1.416 ((62.07)^{***})</td>
</tr>
<tr>
<td>(\Delta TR_{t-1})</td>
<td>0.277 ((6.06)^{***})</td>
<td>0.319 ((18.64)^{***})</td>
<td>0.309 ((17.45)^{***})</td>
<td>0.317 ((19.72)^{***})</td>
</tr>
<tr>
<td>(\Delta TR_{t-2})</td>
<td>0.27 ((4.62)^{***})</td>
<td>0.349 ((17.92)^{***})</td>
<td>0.362 ((19.41)^{***})</td>
<td>0.355 ((14.57)^{***})</td>
</tr>
<tr>
<td>(\Delta R_t)</td>
<td>0.254 ((2.33)^{***})</td>
<td>0.292 ((6.88)^{***})</td>
<td>0.27 ((5.77)^{***})</td>
<td>0.134 ((2.59)^{***})</td>
</tr>
<tr>
<td>(\Delta B_t)</td>
<td>0.25 ((7.56)^{***})</td>
<td>0.287 ((18.60)^{***})</td>
<td>0.339 ((21.39)^{***})</td>
<td>0.333 ((33.70)^{***})</td>
</tr>
<tr>
<td>Observations</td>
<td>408</td>
<td>408</td>
<td>408</td>
<td>408</td>
</tr>
<tr>
<td>Number of panels</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
</tr>
</tbody>
</table>

\(Z\) statistic in parenthesis.  * Significant at 10% level.  ** Significant at 5% level.  *** Significant at 1% level.

We obtain a positive and significant response of current public expenditures to changes in all sources of exogenous revenues. In particular, the estimated response to changes in coparticipation transfers seems to be very important. On average, and other things being equal, for each peso of increase in coparticipation transfers, provincial governments increased current public expenditures between 97.5 cents and 1.416 pesos, depending on the specification we look at. These large estimated responses are similar to those obtained by Craig and Inman (1986), Grossman (1989) and Dahlberg et al. (2008).

For royalties, we also obtain a positive and statistically significant coefficient, but much lower in absolute value than the estimated coefficient for coparticipation transfers. In this regard, for each peso of increase in royalties, provincial current public expenditures increase between 13 and 29 cents. This suggest that provinces have behaved much less expansiornary with respect to this source of income.

The response of expenditures to changes in provincial GPP, though positive and significant, are much lower than the estimated responses to changes in coparticipation transfers and royalties. The estimated coefficient indicates that, per peso of increase in provincial GPP, provincial current public expenditures increase between 0.7 and 1.57 cents. This suggest that, once other sources of income are controlled for, there is a low response of expenditures to changes in provincial GPP, a prox for the local tax base. This result reflects in part the already noted fact that Argentine provinces have a very limited tax capacity.\(^{25}\) Given these tax weaknesses of Argentine provinces, it is difficult to interpret the great gap between the estimated coefficient for changes in provincial private income

\(^{25}\) A legitimate concern regarding provincial GPP is that this variable can be affected by provincial fiscal policies,
and the corresponding for changes in coparticipation transfers as evidence of a "flypaper effect" [see, among others, Gramlich (1977), Hines and Thaler (1995), Bailey and Connolly (1998) and Inman (2008)].

5.2 Robustness checks

5.2.1 Exclusion of big provinces

We have argued that, from the point of view of each province, coparticipation transfers are exogenous. In particular, given that provinces are relative small compared to the national economy, each one takes the national business cycle as given, and thus also consider the evolution of national taxes and coparticipation transfers as exogenously determined. This argument is true for most provinces in Argentina, but it could be criticized for the case of Buenos Aires and the capital C.A.B.A., whose GPPs represent 35 and 25 percent of the national GDP, respectively. To a lesser extent, the same criticism could be applied to Cordoba and Santa Fe, which are the following two largest jurisdictions. To see if this potential channel of endogeneity is in part driving the previous results, in Table 9 we run the same regressions, first taking away the province of Buenos Aires (columns a), then eliminating also C.A.B.A. (columns b), and finally taking away Cordoba and Santa Fe (columns c).

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26 Another reason to exclude the province of Buenos Aires is the following. Since 1992, this province received a special transfer called Fondo de Financiamiento del Conurbano Bonaerense, which in some years amounted to almost 25 percent of its coparticipation transfers. As explained in Section 3, the establishment of this fund was the result of political negotiations that took place after Law 23,548 was enacted. Thus, these extra funds could be a source of endogeneity in the sense that expenditure decisions could been taken place in anticipation of the yearly negotiation of this extra funds.
Table 9: Exclusion of big provinces

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(a)</td>
<td>(b)</td>
<td>(c)</td>
<td>(a)</td>
</tr>
<tr>
<td>(\Delta Y_t)</td>
<td>0.008 2.1\times10^{-4} -0.0005</td>
<td>0.020 0.009 0.008</td>
<td>0.02 0.009 0.0095</td>
<td>0.018 0.008 0.007</td>
</tr>
<tr>
<td></td>
<td>(1.31) (0.00) (-0.06)</td>
<td>(13.63)*** (3.68)*** (3.02)***</td>
<td>(11.40)*** (3.7)*** (3.36)***</td>
<td>(9.6)*** (5.71)*** (3.65)***</td>
</tr>
<tr>
<td>(\Delta Y_{t-1})</td>
<td>0.005 0.009 0.012</td>
<td>-0.004 -0.003 0.014</td>
<td>-0.003 -0.003 0.014</td>
<td>-0.005 -0.004 0.018</td>
</tr>
<tr>
<td></td>
<td>(0.86) (1.25) 1.44</td>
<td>(2.79)*** (-1.15) (5.44)***</td>
<td>(1.64) (-1.18)* (5.11)***</td>
<td>(2.29)*** (-3.54)*** (9.43)***</td>
</tr>
<tr>
<td>(\Delta T R_{t})</td>
<td>0.927 0.94 0.907</td>
<td>1.05 1.08 0.928</td>
<td>1.065 1.092 0.93</td>
<td>1.038 1.05 0.9224</td>
</tr>
<tr>
<td></td>
<td>(21.77)*** (21.68)*** (21.18)***</td>
<td>(57.99)*** (61.06)*** (86.48)***</td>
<td>(69.76)*** (58.8)*** (92.93)***</td>
<td>(57.21)*** (57.25)*** (93.32)***</td>
</tr>
<tr>
<td>(\Delta T R_{t-1})</td>
<td>0.285 0.28 0.274</td>
<td>0.287 0.27 0.26</td>
<td>0.302 0.26 0.26</td>
<td>0.299 0.287 0.258</td>
</tr>
<tr>
<td></td>
<td>(7.64)*** (7.51)*** (7.38)***</td>
<td>(19.79)*** (18.45)*** (26.62)***</td>
<td>(23.44)*** (17.42)*** (28.54)***</td>
<td>(18.05)*** (16.81)*** (26.17)***</td>
</tr>
<tr>
<td>(\Delta T R_{t-2})</td>
<td>0.254 0.25 0.214</td>
<td>0.399 0.337 0.173</td>
<td>0.361 0.328 0.17</td>
<td>0.381 0.325 0.178</td>
</tr>
<tr>
<td></td>
<td>(5.40)*** (5.29)*** (4.58)***</td>
<td>(20.98)*** (17.64)*** (13.49)***</td>
<td>(23.47)*** (16.79)*** (14.51)***</td>
<td>(18.34)*** (20.74)*** (15.37)***</td>
</tr>
<tr>
<td>(\Delta R_t)</td>
<td>0.25 0.276 0.261</td>
<td>0.181 0.216 0.178</td>
<td>0.163 0.211 0.17</td>
<td>0.087 0.099 0.063</td>
</tr>
<tr>
<td></td>
<td>(2.38)*** (2.71)*** (2.61)***</td>
<td>(4.31)*** (4.83)*** (4.17)***</td>
<td>(2.86)*** (4.4)*** (3.94)***</td>
<td>(1.78)*** (0.3) (1.81)*</td>
</tr>
<tr>
<td>(\Delta B_t)</td>
<td>0.244 0.244 0.235</td>
<td>0.255 0.267 0.249</td>
<td>0.27 0.282 0.26</td>
<td>0.248 0.262 0.26</td>
</tr>
<tr>
<td></td>
<td>(8.42)*** (8.38)*** (7.94)***</td>
<td>(23.14)*** (20.5)*** (26.71)***</td>
<td>(32.96)*** (19.86)*** (27.96)***</td>
<td>(22.19)*** (29.59)*** (33.65)***</td>
</tr>
</tbody>
</table>

| Excluding Bs. As. | Y Y Y | Y Y Y | Y Y Y | Y Y Y |
| Excluding C.A.B.A. | N Y Y | N Y Y | N Y Y | N Y Y |
| Excluding Cor., Sta Fe | N N Y | N N Y | N N Y | N N Y |
| Number of panels | 23 22 20 | 23 22 20 | 23 22 20 | 23 22 20 |

Z statistic in parenthesis. * Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level.
As we see, some results change. The estimated coefficient for coparticipation transfers falls from 1.40 (specification 3, Table 8) to 1.065 (specification 3(a), Table 9), and then to 0.93 (specification 3(c), Table 9). Clearly, the impact of Buenos Aires is important: when this province is excluded, the marginal decrease in the coefficient is larger than when the other three provinces are not included. This suggests that, for Buenos Aires, shocks affecting its GPP (closely correlated with the national GDP, due to its economic importance), could have had direct effects on its expenditure and tax decisions, beyond its impact through coparticipation transfers. In this sense, the suspicion of an endogeneity channel is verified.

With respect to the estimated coefficients for royalties, it is still significant and positive, and its change is not negligible. The estimated coefficient falls from 0.27 (specification 3, Table 8) to 0.163 when Buenos Aires is not included (specification 3(a), Table 9); then its change is marginal when the other three provinces are also excluded.

5.2.2 Exclusion of La Rioja

In Section 2, we explained that 1 percent of the Primary Distribution of the common pool Masa Coparticipable finances the provision of ATNs, discretionary transfers decided by the Interior Ministry. For most provinces, these transfers are not important sources of revenues (less than 10 percent of their total income). But this is not the case for all of them. In particular, during 1988 - 1996, La Rioja received, on average, 23.5 percent of all ATNs (Cetrángolo and Jiménez, 2003). In particular, during some years, La Rioja received the same amount of ATNs than of coparticipation transfers. This exceptional situation was mainly due to the fact that President C. Menem was originary from this poor province. As this source of revenues is clearly not exogenous, one may think that some results can change. In the following table, we run the same regressions, but excluding La Rioja from the set of provinces.

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta Y_t$</td>
<td>0.0081</td>
<td>0.0106</td>
<td>0.0157</td>
<td>0.012</td>
</tr>
<tr>
<td></td>
<td>(1.33)</td>
<td>(7.21)**</td>
<td>(11.63)**</td>
<td>(8.82)**</td>
</tr>
<tr>
<td>$\Delta Y_{t-1}$</td>
<td>0.0056</td>
<td>0.004</td>
<td>0.00105</td>
<td>0.0016</td>
</tr>
<tr>
<td></td>
<td>(0.89)</td>
<td>(2.48)**</td>
<td>(0.69)</td>
<td>(1.17)</td>
</tr>
<tr>
<td>$\Delta TR_t$</td>
<td>0.985</td>
<td>1.398</td>
<td>1.405</td>
<td>1.440</td>
</tr>
<tr>
<td></td>
<td>(18.25)**</td>
<td>(65.08)**</td>
<td>(68.91)**</td>
<td>(73.3)**</td>
</tr>
<tr>
<td>$\Delta TR_{t-1}$</td>
<td>0.2768</td>
<td>0.318</td>
<td>0.3058</td>
<td>0.311</td>
</tr>
<tr>
<td></td>
<td>(5.92)**</td>
<td>(18.69)**</td>
<td>(17.42)**</td>
<td>(20.51)**</td>
</tr>
<tr>
<td>$\Delta TR_{t-2}$</td>
<td>0.267</td>
<td>0.349</td>
<td>0.364</td>
<td>0.374</td>
</tr>
<tr>
<td></td>
<td>(4.49)**</td>
<td>(18.05)**</td>
<td>(19.50)**</td>
<td>(25.54)**</td>
</tr>
<tr>
<td>$\Delta R_t$</td>
<td>0.256</td>
<td>0.296</td>
<td>0.274</td>
<td>0.131</td>
</tr>
<tr>
<td></td>
<td>(2.34)**</td>
<td>(6.95)**</td>
<td>(5.83)**</td>
<td>(4.08)**</td>
</tr>
<tr>
<td>$\Delta B_t$</td>
<td>0.256</td>
<td>0.287</td>
<td>0.34</td>
<td>0.329</td>
</tr>
<tr>
<td></td>
<td>(7.46)**</td>
<td>(18.75)**</td>
<td>(21.54)**</td>
<td>(43.53)**</td>
</tr>
<tr>
<td>Observations</td>
<td>391</td>
<td>391</td>
<td>391</td>
<td>391</td>
</tr>
<tr>
<td>Number of panels</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>23</td>
</tr>
</tbody>
</table>

$Z$ statistic in parenthesis. * Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level.

During his two presidencies (1989-1995 and 1995-1999), La Rioja received, on average, 32 percent of the total amount of distributed ATNs.
Results are unchanged with respect to those of Table 8. This suggests that, despite the non-exogeneity of this type of funds, as their amount is very low for almost all provinces, it is not an issue here.

### 5.2.3 Comparison between oil and non-oil provinces

Although we have indicated that the institutional setup of the regime of royalties precludes the possibility that provinces may have influenced their amount (so we should no worry about this channel of potential endogeneity), we can still suspect that the estimated coefficient may be biased because it captures the average response of all jurisdictions in a situation where only few of them actually receive significant incomes from this particular source of revenue. In this context, it could be the case that the estimated coefficient may be biased downwards, because many provinces have cero or near zero observations for this variable. Moreover, we can also argue that oil and non-oil provinces are different in terms of their economic, social and institutional characteristics, which could imply that the response of public expenditures to revenue shocks should also differ for the rest of the variables including intergovernmental transfers.\(^{28}\) To evaluate this hypothesis, in Table 11 we run separate regressions for oil provinces (columns a) and non-oil provinces (columns b). Oil provinces are those whose royalties explain, on average, at least 3% of their total income during 1988 - 2005: Chubut, La Pampa, Mendoza, Neuquen, Rio Negro, Salta, Santa Cruz and Tierra del Fuego.

---

\(^{28}\) There is an important literature on the “Natural Resource Curse” that postulates channels through which natural resource abundance could be associated with bad policy and economic performance [see Van der Ploeg (2011)]. Various papers have applied this framework to study economic outcomes and government policy at the subnational level in Latin America [see Brollo et al. (2010), Caselli and Michæls (2011), Monteiro (2009) and Sanguinetti (2010) among others].
### Table 11: Oil vs. non-oil provinces

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(a)</td>
<td>(b)</td>
<td>(a)</td>
<td>(b)</td>
</tr>
<tr>
<td>$\Delta Y_t$</td>
<td>0.005</td>
<td>0.013</td>
<td>0.02</td>
<td>0.009</td>
</tr>
<tr>
<td></td>
<td>(0.42)</td>
<td>(1.81)*</td>
<td>(2.63)**</td>
<td>(3.29)**</td>
</tr>
<tr>
<td>$\Delta Y_{t-1}$</td>
<td>0.018</td>
<td>0.002</td>
<td>0.019</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(1.49)</td>
<td>(0.33)</td>
<td>(2.55)**</td>
<td>(0.52)</td>
</tr>
<tr>
<td>$\Delta T R_{t}$</td>
<td>0.934</td>
<td>1.002</td>
<td>0.873</td>
<td>1.448</td>
</tr>
<tr>
<td></td>
<td>(10.99)**</td>
<td>(15.40)***</td>
<td>(14.80)**</td>
<td>(52.77)***</td>
</tr>
<tr>
<td>$\Delta T R_{t-1}$</td>
<td>0.2312</td>
<td>0.297</td>
<td>0.259</td>
<td>0.339</td>
</tr>
<tr>
<td></td>
<td>(3.20)**</td>
<td>(5.32)***</td>
<td>(5.18)**</td>
<td>(12.75)***</td>
</tr>
<tr>
<td>$\Delta T R_{t-2}$</td>
<td>0.117</td>
<td>0.32</td>
<td>-0.018</td>
<td>0.368</td>
</tr>
<tr>
<td></td>
<td>(1.30)</td>
<td>(4.48)***</td>
<td>(0.28)</td>
<td>(12.90)***</td>
</tr>
<tr>
<td>$\Delta R_t$</td>
<td>0.164</td>
<td>(-)</td>
<td>0.214</td>
<td>(-)</td>
</tr>
<tr>
<td></td>
<td>(1.59)</td>
<td>(-)</td>
<td>(2.68)**</td>
<td>(-)</td>
</tr>
<tr>
<td>$\Delta B_t$</td>
<td>0.147</td>
<td>0.3077</td>
<td>0.164</td>
<td>0.276</td>
</tr>
<tr>
<td></td>
<td>(3.09)**</td>
<td>(7.06)***</td>
<td>(4.90)**</td>
<td>(31.51)***</td>
</tr>
<tr>
<td>Observations</td>
<td>136</td>
<td>272</td>
<td>136</td>
<td>272</td>
</tr>
<tr>
<td>Number of panels</td>
<td>8</td>
<td>16</td>
<td>8</td>
<td>16</td>
</tr>
</tbody>
</table>

$Z$ statistic in parenthesis. * Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level.
With respect to results obtained in specification 3(c) of Table 9 (i.e., when the biggest provinces were excluded), we observe in specification 3(a) that the estimated coefficient of coparticipation transfers decreases 6 percent points, whereas the estimated coefficient for royalties increases more than 4 percent points.\textsuperscript{29} Regarding non-oil provinces, the estimated coefficient of coparticipation transfers (specification 3(b)) has a similar value as the one found, for the same econometric specification, for the whole sample of provinces.

6 How much Argentine provinces deviate from an optimal public expenditure policy?

In this section, we provide an economic interpretation of our empirical results. In particular, we want to assess whether they imply a high or low public expenditure smoothing, and whether these deviations, if observed, concern all sources of provincial revenues. As suggested by Wyckoff (1991), in order to do this it is convenient to recall the theoretical framework derived in Section 4. The optimal responses of provincial current public expenditures to shocks in each source of revenue are

\[
b_1 \equiv \frac{d\Delta G_t}{d\Delta TR_t} = \frac{1}{(1 + \theta)} \frac{(1 + r)^2}{(1 + r - \rho_{1R})(1 + r) - \rho_{2R}}
\]

\[
d_1 \equiv \frac{d\Delta G_t}{d\Delta R_t} = \frac{1}{(1 + \theta)} \frac{r}{1 + r - \rho}
\]

We should expect that, if the model is relevant in terms of describing actual behavior of provincial governments in Argentina, then the estimated coefficients $\hat{\beta}_1$ and $\hat{\delta}_1$ should be close to the calibrated values of $b_1$ and $d_1$, respectively.

To calibrate $b_1$ and $d_1$, we use the following baseline parameters.

\textsuperscript{29}In the last column of the table, when we run the regression only for the eight oil provinces assuming a panel-specific autocorrelation process, we add eight parameters to be estimated. As the number of observations is relatively low, the estimated coefficient for royalties loses its significance mainly because of the rather low number of degrees of freedom.
Table 12: Baseline parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho_1^{TR}$</td>
<td>0.3449</td>
</tr>
<tr>
<td>$\rho_2^{TR}$</td>
<td>-0.49</td>
</tr>
<tr>
<td>$\rho$</td>
<td>0.975</td>
</tr>
<tr>
<td>$r$</td>
<td>0.09</td>
</tr>
<tr>
<td>$\theta$</td>
<td>3.8983</td>
</tr>
</tbody>
</table>

Estimates of $\rho_1^{TR}, \rho_2^{TR}$ and $\rho$ were obtained in the regressions that appear in Tables 7. In addition, we assume that the real interest $r$ is 9 percent: this is the average international interest rate for the period 1988 - 2005. As in Neumeyer and Perry (2005), the international interest rate corresponds to the redemption real yield on an index of non-investment-grade U.S. domestic bonds. Adopting this value for the real interest rate is in line with the theoretical model, in which there are no distortions affecting credit markets, and thus where the interest rate is equal to the risk-free rate.\footnote{Results do not vary significantly if we assume an interest rate of 5, or even 15 percent.}

Finally, we calibrate the preference parameter $\theta$ as follows. For each province, we obtain the yearly value of its private consumption level by weighting the yearly value of private national consumption with the provincial participation in the country’s GDP.\footnote{The Argentine official statistical institute INDEC does not compute data on provincial private consumption.} Then, we divide this level by the yearly current public expenditures. Then, we average the obtained figures across years to obtain an average provincial calibrated value for $\theta$. Finally, we average across provinces.

Table 13 shows the results. In the first two columns, we include all provinces, and thus we adopt the baseline parameter for $\theta$. In the other two columns, we exclude the biggest provinces from the estimations.\footnote{In this case, the theoretical values of $b_1$ and $d_1$ are obtained adopting the corresponding calibrated value for $\theta = 2.9702$.} In columns 2 and 4, we show the estimated coefficients obtained in the third column of Tables 8 and 90.\footnote{This is our preferred specification as it doesn’t suffer from a problem of lack of (or rather low) degree of freedom by adding several parameters to be estimated when we assume a panel specific autocorrelation process (estimation shown in columns 4 of Tables 8 and 9).}

Table 13: Comparison between theoretical and estimated coefficients

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$b_1, \beta_1$</td>
<td>0.1863</td>
<td>1.40</td>
<td>0.2298</td>
<td>0.93</td>
</tr>
<tr>
<td>$d_1, \delta_1$</td>
<td>0.1598</td>
<td>0.27</td>
<td>0.1971</td>
<td>0.17</td>
</tr>
</tbody>
</table>
Aires, C.A.B.A., Córdoba and Santa Fe are excluded, the gap between the calibrated value and the econometric estimation decreases to four times.

With respect to royalties, the comparisons suggest that oil provinces have smoothed out shocks in these revenues: the estimated coefficients are much closer to the theoretical calibrations than for coparticipation transfers. When all provinces are considered, the estimated coefficient $\delta_1$ is 70 percent higher than the calibrated value of $d_1$. But when the four biggest provinces are excluded, the estimated response to changes in royalties is just 13.7 percent below the calibrated value of $d_1$.

These results enable us to rigorously assert that, both qualitatively and quantitatively, Argentine provinces’ public expenditure behavior overreact to changes in coparticipation transfers, whereas they seem to act optimally when they face shocks to royalties.

Finally, our methodology of contrasting empirical estimations to calibrated theoretical responses of provincial governments’ fiscal policies can also be applied to meaningfully ask whether provincial governments are “procyclical”. This methodology is absent in much of the empirical literature that has evaluated quantitatively the procyclical hypothesis of subnational governments in developing countries [see Sturzenegger and Werneck (2006), Arena and Revilla (2008), Rodden and Wibbels (2010), and Vegh and Vuletin (2011) among others].

6.1 Discussion of results

We have developed a theoretical model whose calibration provides us with a benchmark as to how much current public expenditure smoothing we should expect in Argentine provinces when they face exogenous shocks in coparticipation transfers and royalties. The econometric evidence that estimates the actual reaction of provincial current public expenditures to these shocks suggests that, with respect to this benchmark, there is very little smoothing of coparticipation transfers, but that this is not the case for royalties. Now, the question that arises is why we obtain these results. The discussion that follows tries to suggest some factors that may explain them.\textsuperscript{34}

A first argument that could be made is that credit markets do not work perfectly well. In the model, we have assumed that provinces can freely take loans at the risk-free interest rate, and that they never face credit market restrictions. This is clearly a strong assumption for a country like Argentina that had suffered repeated financial crises during the last decades. With credit frictions that could induce a procyclical availability of loans for provincial authorities, we could potentially explain the observed overreaction of expenditures to national transfers. The reason is the following. In the upside of the cycle (i.e. when the national GDP grows above the trend level), financial resources for provinces abound, in particular coparticipation transfers. So provincial authorities can increase current public expenditures above what is determined by the evolution of current income. On the other hand, in bad times (i.e. in strong recessions), credit is reduced drastically. Provincial authorities need to adjust current public expenditures downward, not only to accommodate public outlays to the lower level of current revenues, but also to pay back loans that are more difficult to rollover. Of course, the key questions are: why credits to local governments comove with coparticipation transfers, but not with royalties? Why this comovement is related to frictions in credit markets? To understand this, we need to mention that, because of credit frictions, banks in general have asked provincial authorities to back up their loans with collateral. In this regard, many provincial governments have pledged coparticipation transfers to fulfill these collateral requirements. Under these financial agreements, if a province fails to honor its debt, the national government would send automatically its corresponding coparticipation transfer to the affected financial institution.

\textsuperscript{34} A quantitative test of the relevance of these factors is beyond the scope of the present paper.
This implies that, if the business cycle makes the value of the collateral to increase or decrease, as is the case with national coparticipation transfers that depend on the national GDP, this would be reflected in the capacity of provincial governments to take loans, and thus to change current expenditures accordingly. As explained in detail by Sanguinetti and Zentner (2000), this practice to collateralize credits with coparticipation transfers has been widely applied during the nineties, and has allowed provinces with rather weak public finances to receive loans from domestic commercial banks. With respect to royalties, there is no evidence that provincial governments have used these extra resources as collateral for bank loans. So, in principle, local authorities in these jurisdictions were not able to improve marginally their access to bank loans than provinces with no hydrocarbon resources.\footnote{Only after 2005, when Argentina has renegotiated its default on the National Public Debt, have some oil provinces like Neuquen and Mendoza issued bonds using royalties as collateral.}

A second argument, not entirely independent from the previous one, is that intergovernmental fiscal institutions in Argentina have implied that some jurisdictions may have faced soft budget constraints [see Qian and Roland (1998), Goodspeed (2002) and Kornai et al. (2003) among others]. These provinces do not need to adjust their expenditure decisions to the current and expected flow of provincial income because they may have the possibility to be rescued by the National Government. The actual occurrence of provincial bailouts in Argentina has been documented by Nicolini et al. (2002). These authors find that, in general, bailouts took place in poor and small provinces, where 80 percent or more of their revenue comes from national transfers, as illustrated in Section 2. Actually, in many cases, these provinces have taken so much debt using coparticipation transfers as collateral that, when these transfers were subject to a negative shock, their current income fell sharply because much of their coparticipation revenues went automatically to their lenders.

\section{Conclusions}

In Argentina, fiscal federalism institutions imply that provinces receive many transfers from the National Government, besides having their own source of revenues. The most important type of transfer comes from a tax sharing rule called \textit{Coparticipación Federal de Impuestos}, where each province's income is predetermined by a legal, fixed coefficient that depends neither on its characteristics nor on its policies' outcomes. In addition to coparticipation transfers, royalties are an important source of income for some jurisdictions. This type of provincial income has been very volatile, and its main source of variation is exogenously determined by changes in international prices. These two features of the Argentine data provide a unique setting for empirically identifying the degree of expenditure smoothing at the subnational level.

The main econometric results are the following. For each peso of increase in coparticipation transfers, Argentine provinces seem to spend, depending upon the specifications, between 91 cents and 1.40 pesos. But, when royalties increase in the same amount, current provincial public expenditure increases between 16 and 30 cents. These results are robust to many different specifications.

Then, we investigate whether the degree of expenditure smoothing observed at the provincial level in Argentina is consistent with predictions coming from a theoretical model of intertemporal fiscal behavior. To do this, we calibrate the model and we compare its results with regression's outcomes. The comparisons suggest a low level of provincial public expenditure smoothing in response to shocks in coparticipation transfers, but that this is not the case for royalties.
References


8 Appendix

8.1 Derivation of changes in current public expenditures

In Section 4, we worked on the first-order conditions of problem (8)

\[ C_s = \theta G_s \]

\[ a\theta (G_s - E_s[G_{s+1}]) = 1 - \beta (1 + r), \]

and assuming that \( \beta (1 + r) = 1 \), we obtained

\[ G_s = E_s(G_{s+1}). \]

Then, we worked with the intertemporal provincial resource constraint to find

\[ G_t = \frac{r}{1 + r (1 + \theta)} E_t(W_t). \]

In order to get an expression for \( G_t \) that can be easily implemented in the empirical analysis, it will be convenient to expand the expected wealth term \( E_t(W_t) \). From (5), we get

\[ E_t[R_{t+s} - \mu] = \rho^s (R_t - \mu). \] (18)

Then, the expected discounted sum of royalties is

\[ \sum_{s=0}^{\infty} \frac{E_t[R_{t+s}]}{(1 + r)^s} = \mu \frac{(1 + r)}{r} + (R_t - \mu) \frac{(1 + r)}{(1 + r - \rho)} \] (19)
Regarding provincial private income, from (7) we have
\[
E_t [\Delta Y_{t+s} - \gamma] = \rho_1^Y (\Delta Y_t - \gamma). \tag{20}
\]
Using (20) and the fact that \( E_t [Y_{t+s}] \) can be expressed as
\[
E_t [Y_{t+s}] = Y_{t-1} + \sum_{i=t}^{s} E_t [\Delta Y_t - \gamma] + (s + 1) \gamma,
\]
we obtain
\[
\sum_{s=0}^{\infty} \frac{E_t [Y_{t+s}]}{(1 + r)^s} = Y_{t-1} \frac{1 + r}{r} + (\Delta Y_t - \gamma) \frac{(1 + r)}{r} \frac{(1 + r)}{1 + r - \rho_1^Y} + \gamma \frac{(1 + r)^2}{r^2}. \tag{21}
\]
Given that the stochastic process followed by transfers is given by a second-order difference equation, obtaining expressions like (18) and (20) is not as immediate. We proceed as follows.
Recall that the stochastic process followed by transfers is
\[
(\Delta TR_s - \phi) = \rho_1^{TR} (\Delta TR_{s-1} - \phi) + \rho_2^{TR} (\Delta TR_{s-2} - \phi) + \xi_s \tag{22}
\]
Let’s define
\[
\zeta_s = \begin{bmatrix} (\Delta TR_s - \phi) \\ (\Delta TR_{s-1} - \phi) \end{bmatrix},
\]
\[
F = \begin{bmatrix} \rho_1^{TR} & \rho_2^{TR} \\ 1 & 0 \end{bmatrix},
\]
\[
v_s = \begin{bmatrix} \xi_s \\ 0 \end{bmatrix}.
\]
With these definitions, we can write the stochastic process of transfers as the following first-order vector difference equation
\[
\zeta_{s+1} = F \cdot \zeta_s + v_{s+1}. \tag{23}
\]
Then, we can obtain \( E_0 [\Delta TR_t - \phi] \) calculating the following inner product
\[
E_t [\Delta TR_{t+s} - \phi] = \begin{bmatrix} 1 & 0 \end{bmatrix} \cdot E_t [\zeta_{t+s}] = \begin{bmatrix} 1 & 0 \end{bmatrix} \cdot F^s \cdot \zeta_t \tag{24}
\]
Using (24),
\[
E_t [TR_{t+s}] = TR_{t-1} + \sum_{i=0}^{s} E_t [\Delta TR_{t+i} - \phi] + (s + 1) \phi,
\]
and
\[
\sum_{i=0}^{s} F^s = [I - F^{s+1}] \cdot [I - F]^{-1}
\]

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where \( I \) is the identity matrix, we get
\[
E_t [TR_{t+s}] = TR_{t-1} + \left[ \begin{array}{c} 1 \\ 0 \end{array} \right] \cdot [I - F^{s+1}] \cdot [I - F]^{-1} \cdot \zeta_t + (s + 1) \phi. \tag{25}
\]

Using (25), the expected discount sum of the transfers can be expressed as
\[
\sum_{s=0}^{\infty} E_t [TR_{t+s}] \frac{(1 + r)^s}{(1 + r)^s} = TR_{t-1} \frac{(1 + r)}{r} + \left[ \begin{array}{c} 1 \\ 0 \end{array} \right] \cdot \left[ \frac{(1 + r)}{r} I - \sum_{s=0}^{\infty} \frac{F^s}{(1 + r)^s} \right] \cdot [I - F]^{-1} \cdot \zeta_t + \phi \frac{(1 + r)^2}{r^2} \tag{26}
\]

Assuming that all eigenvalues of matrix \( F \) verify \( |\lambda_i| < 1 + r \),\(^{36}\) we have that:
\[
\sum_{s=0}^{\infty} \frac{F^s}{(1 + r)^s} = \left[ I - \frac{F}{(1 + r)} \right]^{-1} = \begin{bmatrix}
\frac{(1+r)^2}{(1+r-\rho_1^T)(1+r)-\rho_1^T} & \frac{\rho_2^T (1+r)}{(1+r-\rho_1^T)(1+r)-\rho_2^T} \\
\frac{(1+r)}{(1+r-\rho_1^T)(1+r)-\rho_2^T} & \frac{(1+r-\rho_2^T)(1+r)}{(1+r-\rho_1^T)(1+r)-\rho_2^T} 
\end{bmatrix} \tag{26}
\]

Using expression (26), we obtain
\[
\sum_{s=0}^{\infty} E_t [TR_{t+s}] \frac{(1 + r)^s}{(1 + r)^s} = TR_{t-1} \frac{(1 + r)}{r} + \frac{(1 + r)}{r} \frac{(1 + r)^2}{r} \frac{(\Delta TR_t - \phi)}{(1 + r - \rho_1^T)(1 + r) - \rho_2^T} \\
+ \frac{(1 + r)}{r} \frac{\rho_2^T (1 + r)}{(1 + r - \rho_1^T)(1 + r) - \rho_2^T} \frac{(\Delta TR_{t-1} - \phi)}{(1 + r - \rho_2^T)(1 + r) - \rho_2^T} + \phi \frac{(1 + r)^2}{r^2} \tag{27}
\]

Plugging (19), (21) and (27) in (16), we find
\[
G_t = \frac{1}{(1 + \theta)} \left\{ (\Delta Y_t - \gamma) \frac{(1 + r)}{(1 + r - \rho_1^Y)} + \frac{(1 + r)^2}{r} \frac{(\Delta TR_t - \phi)}{(1 + r - \rho_1^T)(1 + r) - \rho_2^T} + \frac{\rho_2^T (1 + r)}{(1 + r - \rho_1^T)(1 + r) - \rho_2^T} \frac{(\Delta TR_{t-1} - \phi)}{(1 + r - \rho_2^T)(1 + r) - \rho_2^T} \\
+ (R_t - \mu) \frac{r}{(1 + r - \rho)} + (\phi + \gamma) \frac{(1 + r)}{r} + \mu + Y_{t-1} + TR_{t-1} + r B_t \right\} \tag{27}
\]

Lagging the above expression one period and substracting from itself, we obtain expression (17) that describes the optimal change in current expenditures.\[
\]

\(^{36}\)This is true if the system is covariance stationary.