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How do subnational governments react to shocks to revenue sources? Evidence from Argentina*

Martin Besfamille (Universidad Católica de Chile)

Diego Jorrat (Universidad Loyola)

Osmel Manzano (Inter-American Development Bank / Georgetown University)

Pablo Sanguinetti (CAR-Development Bank of Latin America)

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1 Introduction

This paper addresses one of the most important questions in the local public finance literature: How do subnational governments react to shocks to their revenue streams? Oates (2005) and Gamkhar and Shah (2007) identify two generations of contributions that have tried to answer this question. The first is in the theoretical literature that uses analyses of static, neoclassical models of local governments. An issue from that early theoretical literature that attracted a lot of empirical attention is the so-called flypaper effect. This term refers to the empirical observation that the portion of a given increase in federal lump-sum transfers that subnational governments spend far exceeds what they would have spent if private income had increased by the same amount.[1]

But another group of authors argued that most intergovernmental transfers are not issued in lump sums, and their changes are seldom exogenously determined (as had previously been assumed), so transfers are actually affected by fiscal competition and asymmetric information considerations as well as political variables or socioeconomic characteristics of the subnational units. This latter group of authors advised caution about the early literature's interpretation of flypaper effect results. A second generation of contributions has accordingly studied the effect that changes in public income have on subnational fiscal policies, focusing more on incentive problems that emerge in intergovernmental relations. These studies have also emphasized the need to improve identifications issues, to deal with the endogeneity problems prevalent in previous estimations.[2]

This paper belongs to this second strand of the local public finance literature. Specifically, we empirically evaluate how Argentine provinces adapted some of their fiscal policies in response to shocks to revenue between 1988 and 2009. Argentina is an interesting case study for two reasons. First, its subnational governments get their revenue from different sources: provincial taxes, national funding paid out in intergovernmental transfers, and, in some provinces, natural resources royalties.[3] Second, in terms of expenditure, Argentina is highly decentralized, so provinces have a lot of latitude in spending.

To examine how the provinces adapt to shocks, we first present evidence suggesting that changes in the main sources of provincial income from 1988 to 2003 were exogenous and

[1]For surveys on this issue, see Gramlich (1977), Hines and Thaler (1985), Bailey and Connolly (1998), Gamkhar and Shah (2007), and Inman (2008).

[2]See, among others, Knight (2002), Gordon (2004), Dahlberg et al. (2008), Lutz (2010), Lundqvist (2015), Arvate et al. (2015), and Vegh and Vulletin (2015).

[3]In fact, because of institutional features that have prevailed for decades in Argentina, during the period that we analyze, provinces had almost no leeway to modify their own tax collection when they faced a shock to another type of income. So, in this paper, we focus on intergovernmental transfers and natural resources royalties as the relevant sources of provincial revenues.

determined without political intervention. At that time, intergovernmental transfers followed an institutional arrangement under a tax-sharing regime, the *Coparticipación Federal de Impuestos* (Coparticipation). Law 23548 stipulated that most of the taxes collected by the national government constituted a common pool, the *Masa Coparticipable*, that had to be partially shared among all provinces by means of Coparticipation transfers. The law also established that each province's transfer would be a fixed share (or coefficient) of the common pool in a close-end, unconditional, lump-sum grant. Once the law was enacted in 1988, the provincial coefficients were held constant without regard to observed characteristics or policy outcomes. From 1988 to 2003, Coparticipation transfers represented an average of 94 percent of all intergovernmental transfers. At the same time, revenues originating from hydrocarbon production comprised more than 95 percent of all natural resources royalties. But only 8 provinces are hydrocarbon-producing provinces, so those eight received a very large share of the country's natural resources royalties. That said, unlike the fixed-rate Coparticipation transfers, the amount of royalties varied widely because they were mainly determined by international energy prices.

These features of Argentine public finances provide a unique setting for empirically identifying how provincial fiscal policies are modified in reaction to intergovernmental transfers and hydrocarbon royalties, allowing for verification of the key assumption that shocks to these abovementioned sources of public revenues are truly exogenous. Moreover, this setting also enables us to study if these reactions differed according to which source of provincial public revenue was modified.

To do so, we econometrically estimate a system of equations, specifying the provincial responses of public consumption and public debt to contemporaneous and lagged changes in the respective public revenue sources. The main results are the following: First, in all specifications, some of the estimated coefficients of lagged changes in Coparticipation transfers or hydrocarbon royalties are statistically and economically significant. We consider this as indirect evidence that local authorities behave intertemporally. Second, when we consider the period of 1988-2009, provinces spent any increase in Coparticipation transfers by raising public consumption by the same amount as the increase. But when we restrict the analysis to the period of 1988-2003, provinces react more conservatively: When receiving a one-peso (AR$) increase in Coparticipation transfers, the provinces raised public consumption by approximately 32 centavos (1 centavo = AR$ 0.01) and spent 43 centavos to repay their debt. On the other hand, when hydrocarbon-producing provinces faced a one-peso increase in royalties, they used 75 centavos to repay their debt, and we found no impact on their public consumption. These results are robust to different specifications of the basic regressions.

In other words, Argentine provinces showed a non-negligible smoothing behavior between 1988 and 2003, during which time the main sources of provincial revenues were determined exogenously. More importantly, in hydrocarbon-producing provinces, the reaction is more significant with regard to shocks to royalties than to Coparticipation transfers.

We provide two possible explanations for this result. First, we show that the volatility of royalties (both conditional and unconditional) is higher than the corresponding volatility of Coparticipation transfers. Therefore, the reaction of hydrocarbon-producing provinces -- saving more of a given increase in their most volatile source of revenue- can be explained by a precautionary savings argument. Second, according to the literature on the optimal use of revenues from nonrenewable natural resources, hydrocarbon-producing provinces are likely to save most of their royalties when not in initiation and depletion phases of production. We present evidence that these particular provinces were in a mature phase of their hydrocarbons production curve, far from both initiation of exploitation and depletion.

1.1 Related literature

This paper is closely related to the recent strand of the local public finance literature that has empirically analyzed the response of subnational governments to changes in their income streams, paying close attention to the identification strategy. Knight (2002) was among the first to address this issue, showing that federal highway grants in the US crowd out highway spending at the state level. In order to deal with the endogeneity of such grants, he instrumented them with state congressional delegate's measures of political power. Gordon (2004) used a discrete change in the census-based index of poverty to estimate state-level effects of Title I (the most important federal education program in the US) on school spending. Dahlberg et al. (2008) adopted a regression discontinuity design to evaluate the causal effect of a general grant provided by the central government in Sweden on local spending and tax rates. These contributions to the literature studied the impact of only one source of income on fiscal policies, whereas we incorporate a second (hydrocarbon royalties). This enables us to assess whether subnational fiscal policies react differently, according to which revenue source has changed.

In addition, we try to evaluate whether the reaction of fiscal policies to shocks in public revenues could be guided by intertemporal considerations. This hypothesis has already been analyzed in the literature. Holtz-Eakin and Rosen (1991) and Holtz-Eakin et al. (1994) empirically tested the extent to which local government consumption decisions are determined by intertemporal considerations. Using aggregate data for state and local governments in the United States, they performed time series estimations to investigate whether spending is determined by current or more permanent income sources. Although the 1991 study confirmed that public labor demand in small municipalities is consistent with an intertemporal optimizing behavior under uncertainty, the 1994 contribution asserted that local public spending is mainly determined by current resources. Dahlberg and Lindström (1998) applied the same approach to investigate the extent to which local government consumption in Swedish municipalities is determined by permanent rather than current resources, and Borge et al. (2001) extended the analysis to all Scandinavian local governments. Both papers use panel estimation techniques. While Dahlberg and Lindström (1998) found strong evidence in favor of the forward-looking optimizing behavior of Swedish municipalities, Borge et al. (2001) found this assertion to be true for only Danish local governments. More recently, Vegh and Vuletin (2015) used data on federal transfers to Argentine provinces to examine whether uncertainty and insurance arguments, and the resulting precautionary savings behavior, can be consistent with a flypaper effect. We build on these studies by separately estimating expenditures and debt responses to contemporaneous and lagged changes in two distinct exogenous income sources: Coparticipation transfers and hydrocarbon royalties. We confirm that when fiscal rules were implemented without political discretion from 1988 to 2003, Argentine provincial governments seem to have had a less wasteful spending behavior than others have found [see, among others, Sturzenegger and Werneck (2006), Rodden and Wibbels (2010), and Vegh and Vuletin (2015)].

By also including revenue from the exploitation of hydrocarbons, our study ties in with the recent natural resource curse literature that analyzes government performance when a significant portion of their revenues comes from these nontax sources. One of the key arguments of this literature [see van der Ploeg (2011)] is that the nature of these types of income negatively affects both governance and the quality of public policies because voters face weak incentives to control the government when public revenues do not come out of their pockets. This rentier state hypothesis, first postulated by Mahdavy (1970), has been empirically studied in multicountry, cross-sectional growth regressions [see Sachs and Warner (1995)] and, more recently, using panel data estimation which allows for correcting omitted variables biases [see Aslaksen (2010) and Collier and Goderis (2012)].

A drawback of these contributions is that they often use flow indicators of exports or production, which are clearly endogenous. A relatively new strand of papers, in particular Caselli and Michaels (2013), Monteiro and Ferraz (2014), Borge et al. (2015), and Martínez (2016) among others, have analyzed this natural resource curse hypothesis in the context of local governments. Their approach has allowed the potential problems of omitted variable biases to be addressed, as it is much more likely that basic institutional aspects are kept constant (across both sectional units and time) when analyzing political bodies within countries than between countries. In addition, these papers have made an effort to find more exogenous measures of natural resource abundance.[4] As in Martínez (2016), we instrument rev-

[4] For example, Caselli and Michaels (2013) used municipal oil output to instrument for municipal revenue in

enue changes from royalties by time variation in international oil prices and cross-sectional variation in initial oil production. We extend this recent literature by exploring how shocks to these natural resource-linked revenues affect not only provincial decisions regarding public consumption but also debt.

One fiscal policy problem that could be a consequence of the natural resource curse is that hydrocarbon-producing countries seem to have problems at smoothing energy shocks, as originally documented by Gelb (1988). This procyclical behavior has been asserted in more recent papers [see Davis et al. (2003) and Erbil (2011)] that emphasize that factors such as the quality of institutions and the political structure strongly affect results. At the subnational level, Cassidy (2018) uses a natural experiment of a permanent adjustment in the general grant that the government of Indonesia transfers to subnational governments to compare the fiscal response, in terms of the provision of public goods, to this permanent change against transitory shifts in oil revenues. He finds that the increase in permanent income induces more expenditure in lumpy public goods (e.g., investment), while changes in volatile revenues have little or no fiscal response. Therefore, he find that local governments behave well with oil revenues in terms of public goods provision. Our results, which include debt management and the possibility of intertemporal smoothing of fiscal expenditures, also find that Argentine hydrocarbon-producing provinces have behaved -at least during the period under analysis- in a relatively prudent way. These results further contribute to the call for a more cautious view of whether the presence of hydrocarbon revenues is necessarily associated with big fluctuations in fiscal policies.

The remainder of the paper is organized as follows. In next section we describe provincial public finances in Argentina. In Section 3, we detail the institutional settings that rule Coparticipation transfers and natural resources royalties. In Section 4, we empirically estimate how provincial fiscal policies react to changes in the different sources of public revenues. Our results are discussed in section 5, and we conclude in section 6. All supplementary material is presented in the Appendix.

Brazil. Monteiro and Ferraz (2014) used a geographic rule that determines the share of oil revenues that accrue to different Brazilian local governments. Borge et al. (2015) instrumented local revenue from hydropower sources in Norway using indicators of topology, average precipitation and meters of river in steep terrain. Finally, Martínez (2015) exploited time variation in the global oil price, together with cross-sectional variation in oil intensity during a previous period in Colombian municipalities.

2 Sub-national public finances in Argentina

Argentina is composed of 23 provinces plus the region comprising the capital, Ciudad Autónoma de Buenos Aires (CABA).[5] Figure 1 is an administrative map of Argentina.[6]

Insert Figure 1 here

To appreciate Argentina's subnational heterogeneity, Table 1 presents some geographic and socioeconomic provincial statistics. The first three columns display basic geographic and demographic indicators. The following two columns show the Gross Provincial Product (GPP) expressed as a percent of the national gross domestic product (GDP) and in per capita levels in 2004 Argentine pesos (AR$). The last column presents a poverty index showing the percent of households with 'unmet basic needs'.[7]

Insert Table 1 here

The provinces differ in many aspects. There are big provinces (such as CABA, Buenos Aires, Córdoba, and Santa Fe) that together account for more than 60 percent of the country's total population, and generate almost 75 percent of its GDP. There are also provinces with small populations (such as Catamarca, La Rioja, and Santa Cruz, all with less than 1 percent of the total population) or low participation in the national output (such as Formosa, La Rioja, and Santiago del Estero, all producing less than 0.75 percent of GDP). Per capita GPP is also unequally distributed, from AR$3,488 in Santiago del Estero to AR$51,619 in CABA. Although this characteristic is not correlated with the participation of each provincial production in the national GDP, there is a strong negative correlation between per capita GPP and the provincial poverty index.

2.1 The public sector in Argentina

In its national constitution, Argentina adopted a federal, representative republic form of government, that has three levels. The highest is the national government, which has three

[5]As the capital of Argentina, CABA has some special prerogatives. Nevertheless, concerning all the issues analyzed in this paper, this city can be considered a province.

[6]To identify them easily, on the map we highlight some provinces that will play an important role in the discussion of our results.

[7]According to INDEC (1984), a household with 'unmet basic needs' is characterized by, at least, one of the following conditions: (i) more than three individuals per room, (ii) inconvenient house, (iii) no toilet 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.

branches. The executive branch is headed by the president, the legislative branch is led by a bi-cameral congress, and the judicial branch is headed by the Supreme Court of Justice. At the subnational level are CABA and the 23 provinces. As the political units of the federation, each province has its own constitution. The provinces are divided into 2,171 municipalities (as of the 2001 Census). Table 2 shows the size (in terms of expenditure) of each layer of government and the consolidated government as percent of the GDP from 1988 to 2003.

Insert Table 2 here

Clearly, the relative size of the national government has decreased during these years. As a result, the provincial and municipal public sectors have increased their share in the consolidated public sector from 29.81 and 5.24 percent to 36.12 and 8.18 percent, respectively.[8] These aggregate figures hide great differences among the provinces, and Table 3 shows the average size of provincial public sectors, this time as percent of their respective GPP, from 1988 to 2003.

Insert Table 3 here

Comparing this table with Table 1, we observe that the size of the provincial public sector is negatively correlated with per capita GPP and positively correlated with the poverty index.

2.2 Expenditures

According to the constitution, the national government has an exclusive control over some domains, namely defense and foreign affairs, but the national and subnational governments share responsibilities and service provision for a broad range of public services (such as economic infrastructure, social insurance, and poverty programs). Primary and secondary education, municipal organization, and local services, on the other hand, are the exclusive realm of the provinces.

As already mentioned, participation of provincial public expenditures in the consolidated public sector outlays rose from 29 percent at the beginning of the 1980s to 36 percent in 2003. Despite the fact that there are important differences in public outlays between Argentine provinces (both in absolute and per capita levels), their expenditures are concentrated in public consumption (public wages, procurement of inputs, and services) and transfers (mostly pensions). Table 4 shows the average percentage of public consumption and transfers in total public expenditures, by province, between 1988 and 2003.

[8] As municipalities play a minor role in local public finances in Argentina, we focus on fiscal behavior only at the provincial level.

Insert Table 4 here

For most provincial governments, these two components of public expenditures represent, on average, more than 80 percent of their total public outlays.

2.3 Revenues

The Argentine constitution explicitly asserts that the national government has the exclusive right to tax foreign trade. Indirect taxes can be set by either the national government or provincial authorities. But only provinces can directly tax their respective populations or firms in their jurisdictions. Nevertheless, the national government can constitutionally set direct taxes under special circumstances.

During the XIXth and the beginning of the XXth century, the national government mainly raised taxes 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 began to collect taxes that were previously assigned to the provinces, invoking the aforementioned special circumstances argument. Then, provinces started to 'delegate' the administration of the most important taxes (personal and corporate income taxes, consumption taxes, and taxes on wealth) to the national government.[9] This delegation has persisted until the present, but it became more stringent at the end of the 1980s because, according to Law 23548 (discussed below), provinces cannot create new taxes.

As a consequence, Argentina presents a lower degree of decentralization in revenues than expenditures. From 1988 to 2003, the national government collected, on average, 77 percent of the country's tax revenues, whereas provinces (and municipalities) raised only 23 percent. Provinces' tax collection amounted to an average of 2.14 percent of their GPP. As Figure 2 shows, these shares were rather constant during that time. For all provinces, the best fit line of their yearly share of provincial tax collection over GPP presents no statistically significant slope or, when it is statistically significant, its economic significance is negligible.[10]

Insert Figure 2 here

What explains these low percentages? First, provincial revenues are concentrated in only a few taxes. During this period, gross receipts, real state, and vehicle taxes generated, on

[9] This delegation has implied the definition of tax bases and the setting of tax rates by the Congress, whereas tax collection and other regulatory aspects (e.g., tax enforcement) has been undertaken by agencies of the executive branch.

[10] In Section 4.4.3, we study the case of Santiago del Estero in more detail because it is the province whose tax receipts increased the most from 1988 to 2003.

average, 81 percent of provincial fiscal revenues. In particular, the gross receipts tax explains 64 percent of these revenues. As this particular tax is multiphasic and cumulative, its tax rates are usually relatively low (around 1.5 - 1.7 percent) and can hardly be increased. Di Grescia (2003) applies stochastic frontier techniques and shows that provinces exerted a non-negligeable tax effort: From 1960 to 2002, they were able to collect, on average, 91 percent of the potential base of this tax. Therefore, provinces face structural difficulties in increasing revenues on the gross receipts tax and a fortiori on all taxes in general.

This gap between expenditures and tax revenues generates an important vertical fiscal imbalance, partially solved through a system of intergovernmental transfers, which is based on a tax-sharing regime called *Coparticipación Federal de Impuestos*,[11] regulated by Law 23548 (1988). Of the country's 23 provinces, some also receive royalties from natural resources.

Since the mid-1980s, Coparticipation transfers represented, on average, more than 60 percent of provincial revenues, while provincial taxes comprised about 20 percent and royalties fluctuated around 10 percent. Thus, these three sources of revenues amounted on average to almost 90 percent of total public income.[12] Again, there are significant differences across provinces. Table 5 presents average provincial data on revenue composition for 1988 to 2003.

Insert Table 5 here

The capital, CABA has a low dependency on Coparticipation transfers because its local tax base is quite large. For all the other provinces, the average share of Coparticipation transfers is around 60 percent of public income, and for some of the small and poor provinces (e.g., Catamarca, Corrientes, Formosa, and Santiago del Estero), this share is above 80 percent. Table 5 shows that for Chubut, La Pampa, Mendoza, Neuquén, Río Negro, Salta, Santa Cruz, and Tierra del Fuego royalties represent a non negligible fraction of their fiscal revenues. These eight provinces, which were highlighted in Figure 1, have large hydrocarbon resources and concentrate, on average, more than 95 percent of all royalties earned in Argentina from 1988 to 2003.[13,14] For three of them (Chubut, Santa Cruz, and Tierra del Fuego),

[11] See Porto (2004) for a detailed description of the historical evolution of Argentine tax-sharing regimes.

[12] The remaining 10 percent of provincial revenues includes *Aportes del Tesoro Nacional* (ATNs), transfers that are distributed discretionally by the Ministry of Interior, and other transfers from the national government.

[13] From now on, we call these eight provinces the 'hydrocarbon-producing provinces'.

[14] As expected, hydrocarbon-producing provinces received royalties from oil and gas exploitation, but not exclusively. For example, in 1992, Neuquén earned 13 percent of its royalties from hydroelectricity generation. The other provinces with some hydrocarbon resources are Formosa and Jujuy, but they received very few royalties. Regarding incomes from other natural resources, Catamarca and San Juan mostly earned royalties from mineral exploitation whereas Corrientes, Entre Ríos, and Misiones earned some royalties from hydroelectricity generation.

royalties are more important than their own tax revenues, and for one (Neuquén), than the Coparticipation transfers.

2.4 Debt

The other instrument that helps to close the vertical fiscal gap is domestic and foreign debt issuance by provincial governments. During the period under analysis, provincial authorities borrowed domestically, mainly from commercial banks (either private or public) and the national government. They also issued international public bonds and received loans from multilateral financial institutions.

Many provinces formally restricted the issuance, use, and level of their debt. Examples of these restrictions include the following: i) provincial authorities needed to obtain authorization from their own legislature by a specific majority vote to issue new debt, ii) debt could not be used to fund current expenditures or deficits, and iii) most provincial constitutions limited debt services up to a maximum percent of public income. But, as the history of Argentina indicates, to analyze a given policy in this country, it is not sufficient to look at the legal prescriptions that define it; one has to determine whether these legal prescriptions have in fact been implemented and/or enforced. Sanguinetti and Zentner (2000) showed that such restrictions were seldom binding.[15]

Also, since 1993, provincial governments had to be authorized by the Ministry of Economy to issue debt in foreign currencies. But this mandate established neither a quantitative restriction on the level of debt that could be issued nor a ceiling on the amount of Coparticipation transfers or royalties that could be put up as collateral to secure loans. By 2007, no province had been denied such authorization.

All this implies that provinces had a lot of latitude to deal with budgetary difficulties using debt, which was indeed the case. From 1988 to 2003, the consolidated debt of Argentine provinces rose from less than 4 percent to 18.79 percent of GDP. Again, these aggregated figures hide important differences between provinces. Table 6 shows the average provincial per capita stock of debt for the period and the coefficients of variation of these stocks.

Insert Table 6 here

The contrast between average provincial stocks of per capita debt is important: The figure in La Rioja represents more than 61 times the one in Córdoba. Moreover, the coefficients of variation also show large differences in the variance of these stocks.

[15] The paradoxical case is Formosa. Although its constitution limits debt services to 25 percent of yearly public income, they reached 93.35 percent in 1997.

3 Institutional features of nontax provincial revenues

3.1 Coparticipation transfers

Law 23548 defines the process by which taxes collected by the national government are apportioned among the provinces. It also states that, as of its enactment, provinces cannot create new taxes. The peculiarities of this legal framework are explained in detail below, and Figure 3 illustrates the main features of the law.

Insert Figure 3 here

First, the law stipulates that with the exception of specific earmarked taxes and import or export duties, taxes collected by the national government will form the *Masa Coparticipable*, the common pool. The law specifies a primary distribution of this common pool as follows: 44.3 percent corresponds to the national government, 54.7 percent is shared among all provinces, and the remaining 1 percent makes up a fund called *Fondo de Aportes del Tesoro Nacional*, to help provinces facing unforeseen contingencies.[16] The law also establishes the secondary distribution from the part of the common pool that is assigned to all provinces, with each province receiving a fixed share, called coefficient. These coefficients of the secondary distribution are set in Section 4 of the law, as shown in Table 7.

Insert Table 7 here

To explain how these coefficients were determined, it is necessary to understand the tax-sharing regime that was in place before 1988. In 1973, the first law to uniformly regulate the Argentine tax-sharing regime had been enacted. Law 20221 had a stipulated duration of 10 years and specified (secondary distribution) coefficients using an explicit formula that weighted provincial population (65 percent), a 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 (Radical Party) government decided to keep Law 20221 in place. At the end of 1985, the law expired, and because no political consensus to pass a new law emerged, provinces received national transfers that were decided by the Congress between 1985 and 1987. At the beginning of this period of legal vacuum, the pattern of these transfers across provinces was similar to the one observed under Law 20221. But after the Peronist opposition won the 1987 legislative elections, negotiations in Congress started to reflect the new distribution of political power, and the pattern of transfers changed. When the

[16]In fact, this fund finances ATNs distribution mentioned in footnote 12.

Congress finally enacted Law 23548 in January 1988, the legal coefficients in the law replicated the shares that had been obtained by each province during the months before the law went in place.

Law 23548 did not specify coefficients for CABA and Tierra del Fuego because these jurisdictions were not provinces when it was enacted. In 1996, the capital of Argentina became autonomous, and in 2003, Decree 705 fixed CABA's Coparticipation coefficient at 1.4 percent, taken from the national government's part in the primary distribution. In 1990, the National Territory of Tierra del Fuego, Antártida Argentina e Islas del Atlántico Sur had become a province as well. Since then, from the national government's part of the primary distribution, 0.388 percent has been allocated to the province. In 1993, the national government accepted to temporarily transfer to Tierra del Fuego an extra 0.312 percent, again taken from its part in the primary distribution. In 1999, Decree 702 permanently fixed Tierra del Fuego's transfer at 0.7 percent of the common pool *Masa Coparticipable*.

Since the mid 1990's, some authors (e.g., Casás (1996)) have warned that intergovernmental fiscal relations in Argentina were in fact more complex than those depicted in Figure 3. Indeed, after 1990, several laws regulating the distribution of specific taxes to finance predetermined activities have been enacted. For example, Law 24699 specifies that, from the total income tax collection, AR$440 million should be annually deducted from the common pool *Masa Coparticipable*, to be shared among all provinces. Also, various reforms introduced new types of transfers in addition to those set by the Coparticipation regime. For example, Law 24130 stipulates that AR$545 million should be taken from the common pool *Masa Coparticipable* to finance a fund to compensate provincial financial disequilibria, called *Fondo Compensador de Desequilibrios Provinciales*, (85 percent) as well as the National Pension System (15 percent). Despite the fact that these laws modified the Coparticipation regime, making it more intricate, in most of the cases the sharing of these particular funds has been made according to constant and fixed coefficients, similar to those defined by Law 23548.[17] Therefore, we can assert that these changes were more formal than real.

This tax-sharing regime is characterized by the following features. First, there is no political agreement or bargaining in Congress (or any other political body, such as the Australian *Commonwealth Grants Commission*) about the secondary distribution. Second, the coefficients have been legally fixed since 1988.[18] Third, the coefficients are not defined by a formula,

[17] The largest transfer to provinces that partially depends on provincial governments policies is called *Fondo Nacional de la Vivienda* (FONAVI), a fund that helps provinces to build social housing. In 1996, FONAVI amounted to AR$970.1 million, only 6.7 percent of all transfers. Hence, for any given province, the impact of FONAVI on its budget is minor.

[18] In fact, Law 23548 is extremely difficult to modify. According to the Constitution, a new law regulating intergovernmental fiscal relations i) has to be initiated by the House of the Senate, ii) has to be approved by

as in Canada's *Equalization Program* or Germany's *Laendersteuern*, so Coparticipation coefficients are not related to observable exogenous (geographic, demographic, socioeconomic) provincial characteristics, to expenditure plans or outcomes of provincial policies. This particular feature of the Coparticipation regime does not generate incentives within provinces to set their policies' outcomes or manipulate socioeconomic indicators in order to obtain more resources from the national government. In fact, Coparticipation transfers are closed-end, unconditional, lump-sum grants. They are closed-end because there are no limits on the absolute amount of resources that a province can receive or on the percent of its revenues that can come from the national government. The transfers are also unconditional because the national government cannot dictate to provinces how to use these funds. Finally, Coparticipation transfers do not have explicitly or implicitly matching provisions.

Clearly, among federations, Law 23548 defines a unique institutional context of intergovernmental relations. But, as we have already mentioned, we need to verify whether Law 23548's prescriptions were observed and enforced in order to consider Coparticipation transfers as an exogenous source of provincial income. We present three pieces of evidence to show that this was indeed the case. Figure 4 depicts the aggregate amount of Coparticipation transfers as the percentage of all transfers received by provinces, between 1983 and 2009.

Insert Figure 4 here

The figure shows three distinct periods. Before 1988, the percentage changes yearly. As we have already mentioned, between 1983 and 1985, Coparticipation transfers were set according to Law 20221 and depended in some way on provincial policies.[19] Then, between 1985 and 1987, all intergovernmental transfers were decided by Congress, so the allocation of these funds resulted from the outcome of political negotiations between provincial representatives with different bargaining power. Once Law 23548 was enacted in January 1988, Coparticipation transfers from 1988 to 2003 represented a fairly constant and important share of all intergovernmental transfers in Argentina. Indeed, the average share, which is depicted in the figure as a horizontal dotted line, is equal to 93.99 percent.

After 2003, these shares started to decline. From 2004 to 2009, their average was 81.88 percent. Although Law 23548 continued to rule the tax sharing regime, intergovernmental fiscal relations were essentially different than in previous years. This change was mainly due to an important increase in the distribution of discretionary transfers by the national

absolute majority of each congressional house, and then iii) has to be approved by all provincial legislatures.

Although the 1994 constitutional amendment mandated the Congress to approve a new Coparticipation law by 1996, this has still not happened.

[19]Indeed, the development gap indicator in the secondary distribution formula defined in Law 20221 was built using, as explanatory variables, housing quality, cars per inhabitant and degree of education.

government.[20] According to Artana et al. (2012), the use of discretionary transfers tripled from 0.5 percent of GDP at the end of the 1990s to an average of 1.7 percent of GDP in more recent years. Moreover, since 2003 discretionary transfers have not been distributed on an equal basis or distributed following the pattern of their assignment in previous years (see Appendix 7.1).

Figure 5 plots the time series of Coparticipation transfers (in millions of 2004 pesos), for each province between 1988 and 2005.

Insert Figure 5 here

We can observe a fairly common pattern of evolution of provincial Coparticipation transfers across time, consistent with the fact that each of these transfers is a fixed share of the common pool *Masa Coparticipable*.[21] Thus, their evolution reflects, in great part, shocks to the national economy.

Finally, Figure 6 depicts, for each province, the annual amount of its Coparticipation transfer as the percentage of total Coparticipation transfers distributed to all provinces between 1988 and 2003.

Insert Figure 6 here

For all (except three) provinces, the best-fit line of their yearly share of the secondary distribution presents no statistically or economically significant slope.[22]

These three figures prove that between 1988 and 2003, Coparticipation transfers accounted for an average of 94 percent of all intergovernmental transfers. These transfers depended upon the national tax collection, and were apportioned strictly according to the secondary

[20] During the 2001-2002 macroeconomic crisis, the national government introduced taxes on exports and financial transactions whose revenues were not part of the common pool *Masa Coparticipable*. Using emergency powers that were delegated by Congress to the executive branch in 2002 (and renewed every year until 2010), the Ministry of Interior was able to allocate these extra revenues at will.

[21] This common evolution can also be perceived after 2003, confirming that Coparticipation transfers were still distributed according to the secondary distribution defined in Law 23548.

[22] The exceptions are Buenos Aires, CABA, and Tierra del Fuego. The best-fit line of Buenos Aires depicts an increasing trend, mainly explained by the fact that after 1992, this province received a special transfer called *Fondo de Financiamiento de Programas Sociales en el Conurbano Bonaerense*. This transfer, whose funding came from the common pool *Masa Coparticipable* (before its primary distribution), amounts to AR$650 million and has been held constant (in nominal terms) since 1992. Observe that after this year, Buenos Aires's corresponding percentage is fairly constant. The best-fit line of CABA is characterized by a decreasing trend, mainly explained by changes during the 1989-1990 crisis. But after that event, CABA's corresponding percentage is fairly constant. Finally, the best-fit line of Tierra del Fuego depicts an increasing trend, as its legal coefficient was upwardly adjusted twice. In Sections 4.4.2 and 4.4.3, we check whether these issues affect our results.

distribution set in Law 23548, with no intervention of the national government, not even during the 1989 hyperinflation. Thus, Coparticipation transfers can be considered by provinces as a random, exogenous source of public income.

3.2 Royalties

The regime of hydrocarbon royalties was determined by Law 17319, enacted in 1967, which established a common procedure to cash these royalties that applied to all provinces. Under this regime, the national government set a uniform rate for all provinces of 12 percent of the value of oil and/or gas computable production,[23] evaluated at domestic prices at the production site.[24] Moreover, the Secretary of Energy was put in charge of auditing whether firms accurately reported their level of production. Royalties were collected by the national government then transferred, according to a pure devolution criterion, to the provincial governments where the oil and/or gas exploitation had originally taken place.

Surprisingly, this procedure was not altered even after the 1994 constitutional amendment that granted the property of oil and gas resources to the provinces. Though the domain of production sites started to be under provincial jurisdiction, in 2009 the regulation of hydrocarbons exploitation was still under the direct oversight of the national government.

Before 2002, domestic oil and gas prices had been equal to their corresponding international prices because no public intervention (e.g., taxes) created a wedge between those prices and during most of the period from 1988 to 2002, the exchange rate was fixed under *Convertibilidad*, a currency board regime that pegged the Argentine peso to the US dollar. But things changed after the 2001-2002 crisis, when not only was the currency board abandoned, but the state also started to intervene in the energy industry. In particular, after 2003, the Secretary of Energy imposed a maximum price for hydrocarbons produced in the country to attenuate the impact of increasing international oil and gas prices on the Argentine economy. Domestic prices and royalties therefore separated from international prices. Figures 7 and 8 depict the evolution of royalties between 1988 and 2009 for hydrocarbon-producing provinces and the international oil price, respectively.

Insert Figures 7 and 8 here

Despite the important socioeconomic and geological differences among hydrocarbon-producing provinces, their royalties fluctuated similarly, most of the years following the international

[23]Decree 1671 (1969) defined computable production as the net production of oil and gas, after impurities, hydrocarbons used as inputs, and unforeseen losses are subtracted from gross production.

[24]Law 17319 prohibited the national government from setting different rates across provinces.

oil price.[25], [26]

But we can observe that after 2002, royalties seem to increase less than the international oil price. In order to assess whether the post-2003 state intervention had an effect on the evolution of hydrocarbon royalties, Figure 9 presents scatter plots showing how changes in per capita provincial royalties depended on changes in the international oil price for two distinct periods of time.[27] The relation between these changes was statistically significant in both periods, but it shifted in 2003: In panel A, the best fit line has a positive slope and in panel B, a negative one. Since 2004, changes in royalties have not followed the evolution of the international oil price; instead, they have depended more on national government regulations.

Insert Figure 9 here

As we have already mentioned, provinces could also earn royalties on mineral exploitation and hydroelectricity generation. Law 24196 (1993) regulated the system of mineral royalties that had prevailed under the old Code of Mines (1887). This law authorized each province to freely set their royalties, provided they did not exceed 3 percent of the 'pithead value' of mineral extracted -a concept so ambiguous that in 1999 the Congress had to clearly define it, in Law 25161.

Law 23164 (1984) stated that provinces with hydroelectricity generation would receive 12 percent of the value of the electricity sold for consumption.[28] Although this legal framework seems to be similar to the regime that regulated hydrocarbon royalties, it is more complicated. In order to generate hydroelectricity, any producer (whether public or private) needs to obtain not only the authorization to build a facility (e.g., a dam) but also a concession for the use of the water. Both administrative acts are decided by the provincial government, which also defines their corresponding monetary value.

[25]Although hydrocarbon royalties include those coming from gas exploitation, we consider their dependence with respect to only the international oil price. In Section 4.1, we explain why not incorporating the international gas price into the analysis is without a loss of generality.

[26]The exception is 1989, when the international oil price increased substantially but royalties decreased in all hydrocarbon-producing provinces. But this year is an exception, because in July Argentina faced hyperinflation and the resignation of President Raúl Alfonsin.

[27]In panel A, we excluded the changes that took place during the period of hyperinflation in 1989 because they are outliers.

[28]Law 23164 stipulated that if a river from which hydroelectricity is produced flows to more than one province, royalties should be shared among these provinces 'in a reasonable way'. This issue generated inter-provincial disputes (for example, between Mendoza and La Pampa) that have lasted for years (with the corresponding interruption in the payment of these royalties) and required resolution by the Supreme Court of Justice.

Therefore, these last two legal regimes differ from the one that regulates hydrocarbon royalties because provinces hold some prerogatives to define, in some sense, the amount of money they may earn.

4 Empirical analysis

In this section, we empirically investigate how fiscal policies react to changes in different sources of income at the provincial level. First, we discuss the identification strategy, then the data employed, and finally, the main results and some robustness checks.

4.1 Identification strategy

As in Holtz-Eakin et al. (1994) and Dahlberg and Lindström (1998), we conjecture that provincial governments optimally choose their intertemporal fiscal policy (here, public consumption and debt), considering institutional features and the way intergovernmental fiscal relations take place in Argentina. All provinces receive Coparticipation transfers, but only some earn royalties. We assume that provincial authorities consider both sources of income as exogenous and random and follow different stochastic processes. Provincial governments can also tax their residents and issue debt freely. Regarding the former, as was the case in the provinces between 1988 and 2003, we observe almost no ability to modify their own tax revenues, so we take the provincial tax collection as a fixed, small fraction of private sector output, which is another exogenously determined random variable.

We estimate the following system

$$\begin{cases} \Delta G_{i,t} = cons + \sum_{s=0}^{3} \alpha_s^G \Delta TR_{i,t-s} + \sum_{s=0}^{3} \beta_s^G \Delta R_{i,t-s} + \sum_{s=0}^{3} \gamma_s^G \Delta Y_{i,t-s} + \varrho_i + d_t + \nu_{i,t} \\ \Delta D_{i,t} = cons + \sum_{s=0}^{3} \alpha_s^D \Delta TR_{i,t-s} + \sum_{s=0}^{3} \beta_s^D \Delta R_{i,t-s} + \sum_{s=0}^{3} \gamma_s^D \Delta Y_{i,t-s} + \varrho_i + d_t + \mu_{i,t} \end{cases} \quad (1)$$

where i represents a province and t, a year. Contemporaneous changes in public expenditures and public debt are denoted by $\Delta G_{i,t}$ and $\Delta D_{i,t}$, respectively. Explanatory variables include contemporaneous, one-, two-, and three-period lagged changes in Coparticipation transfers $TR_{i,t}$ and royalties $R_{i,t}$.[29] As provinces have almost no leeway to improve their own

[29]We incorporate lagged changes ($\Delta x_{t-s} = x_{t-s} - x_{t-s-1}$) in all independent variables to recognize that if provincial authorities optimize intertemporally, shocks to exogenous sources of income in $t-s$ will affect contemporaneous and future levels of expenditures and debt. Besfamille et al. (2017) present a simple model to justify the inclusion of such lagged changes.

tax collection, we use provincial GPP, $Y_{i,t}$, to control for this source of income.[30] As all variables may be integrated of order one, a first differences model is used to avoid spurious regression results.

Besides the abovementioned explanatory variables, we include provincial fixed effects (ϱ_i) and time dummies (d_t) in all regressions. The addition of provincial fixed effects allows us to capture any factor that affects individual provincial fiscal decisions that remain constant across time, while the time dummy captures shocks that are common to all jurisdictions.

Finally, $\nu_{i,t}$ and $\mu_{i,t}$ are the error terms. Because changes in public expenditures and debt can be simultaneously chosen by provincial governments, it is reasonable to think that $\nu_{i,t}$ and $\mu_{i,t}$ are correlated. Thus, we estimate system (1) using a seemingly unrelated regressions (SUR) model, to gain efficiency by combining information on both equations.[31]

The estimation of system (1) faces several potential problems, the most obvious being that Coparticipation transfers and royalties can be endogenous. Regarding the former, we follow the analysis of Dahlberg et al. (2008) on potential endogenous biases when estimating the effect of central government grants on local government spending. We use the features of Law 23548 to argue that Coparticipation transfers can be considered exogenous with respect to the provinces' characteristics and their fiscal policies, validating our estimation strategy. In particular, we check the following four issues.

First, we address the theoretical argument that if the grant system is designed in negotiations between regional representatives in Congress, their bargaining power and preferences for local spending will affect the distribution of transfers among regions. If this were the case in our context, statistical correlations between Coparticipation transfers and public expenditures or debt may reflect the role of these unobserved characteristics rather than the effect of these type of revenues themselves. Here, these worries are not justified because, as shown in Section 3.1, the secondary distribution of Coparticipation transfers is automatically determined by fixed coefficients that have remained constant since the beginning of the regime and during the period under analysis. In other words, since 1988, no bargain between provincial representatives at the Congress could have affected the distribution of these

[30]But this raises another issue. Can fiscal policies affect provincial GPP, for example via public investment? As this outlay represents a minor share of their budget, we assume that provincial governments do not have the capacity to promote GPP growth in this way. This reflects one of the main recurrent problems that Argentine provinces have been facing for decades, as acknowledged by Porto (2004).

[31]We estimate the seemingly unrelated regressions model considering provinces as a pooled data, controlling for fixed effects by province and year. It was not possible to estimate the model using the panel structure. To check if this is an issue, we estimate each equation in system (1) separately, using a panel structure. Results are similar to those found in Table 9, and are available upon request from the authors. This suggests that our results are not sensitive to panel-level effects.

transfers.[32] Hence, no political channel like the one analyzed by Knight (2002) can create an endogeneity problem here. One could also argue that some socioeconomic and political, observable and non-observable, provincial characteristics that had an influence during the negotiations of the enactment of Law 23548 in the last months of 1987 could have affected provincial public expenditures decisions later on, which could be a potential source of endogeneity that can bias the estimations. To control for these factors, assuming they were kept constant during the period we analyze, we include provincial fixed effect in the regressions.

Second, we consider that even in the absence of negotiations, local economic or political variables might matter because, as stated by Johansson (2003), central-government politicians may want to favor specific regions. To do so, they would strategically tailor the design of intergovernmental transfers to depend upon the preferred regions' particular economic or political characteristics. Therefore, regional characteristics could also indirectly affect expenditure patterns, inducing an endogenous bias in the estimation. This bias is absent in our analysis because the national government could not, and did not, modify the resource allocation across provinces, as stated in Law 23548. This observation rules out this potential concern for endogeneity.

Third, we examine whether observable local socioeconomic characteristics may influence the way provincial expenditures are determined and how Coparticipation transfers are distributed. Again, this potential endogeneity bias is absent for these types of transfers because their distribution did not depend on observable provincial characteristics, as was the case with the previous Coparticipation regime defined by Law 20221 (see Section 3.1). Any provincial characteristic that, as a remaining effect of Law 20221, could still be implicitly associated with the distribution of Coparticipation transfers (e.g., provincial density) is controlled for by the provincial fixed effect.

Fourth, we address whether unobserved characteristics and shocks, specifically those that are temporal -affecting both the distribution of transfers and expenditure decisions by provinces- could constitute 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., a change in the international interest rate) is controlled for by the time dummy. But we could also think about temporary shocks that, affecting the GPP of a particular province, would have an impact on the national GDP, and thus, via the amount of taxes collected by the national government, on Coparticipation transfers. For example, this may happen if the GPP of a

[32] Vegh and Vulletin (2015) analyze the response of provincial expenditures to federal transfers in Argentina from 1960 to 2006. During this extended period of time, there were several changes in the intergovernmental transfers regime [see Porto (2004)], where negotiations in Congress played a key role. This explains why these authors use changes in the index of provincial representation in Congress as an instrument for federal transfers. As we argue in the text, this is not necessary in our case.

particular province represents an important fraction of the national GDP. These shocks could have independent and direct effects on public spending in this particular, affected province, which would induce a bias in the estimation. In Section 4.4.2, we deal with this potential source of endogeneity by adding a dummy variable that captures the identity of these big provinces and analyze whether their reactions differ from those of less influential provinces.

Some issues regarding royalties may invalidate our exogeneity assumption. First, we know that this variable in our data set is subject to measurement errors: Even for hydrocarbon-producing provinces, royalties include those coming from mineral resources and hydroelectricity generation.[33] And, as we explained in Section 3.2, the latter clearly depend on decisions adopted by provincial authorities, and thus could be potentially endogenous.

Second, even if we focus only on hydrocarbon royalties, we may face a problem of reverse causality because one of their determinants is oil and/or gas production. In principle, such a variable could depend not only on the geological features of each site, but also on the outcomes of provincial policies. Indeed, infrastructure or any other public good could affect firms' decisions to initiate the exploitation of a given site or their production process. These policies define the business climate in a given province and may also be correlated with public expenditures.

Finally, unobserved shocks affecting both the level of royalties and expenditure decisions could also be relevant. For example, a strike by oil or gas workers that generates social unrest could affect hydrocarbon production (and thus royalties) and provincial expenditures (because provincial authorities increase social programs to appease such a political situation).[34] This could generate a spurious correlation among these variables, biasing the estimation results.

To address these concerns, we run the regressions using the following variable as an instrument for provincial royalties,

$$Z_{i,t} \equiv q^{o}_{i,1987} \cdot p^{*}_{t}$$

where $q^{o}_{i,1987}$ is province i's oil production in 1987 and p^{*}_{t} is the international oil price.

The first component of $Z_{i,t}$ is as a measure of oil abundance. This ensures that changes in oil production that occurred after 1988 in this province (that could eventually depend indirectly upon governmental decisions) will not affect the evolution of the instrument Z, ensuring an exogenous variability in the first stage.

[33] For the period of 1988 to 2009, disaggregated data by origin of royalties is, to the best of our knowledge, not available for all provinces -not even for the eight hydrocarbon producers.

[34] These kinds of events have indeed been observed in some hydrocarbon-producing provinces, like Neuquén (in 1996 and 1997) and Salta (in 1997).

The use of p_t^* as the second component of $Z_{i,t}$ deserves some discussion. First, Pindyck (2004) documents that the international oil price determines the international gas price, but not the other way around. Thus, we do not need to take the value of the international gas price into account. Second, as Argentine provinces are, globally speaking, small hydrocarbon producers, p_t^* is clearly orthogonal to provincial characteristics and policies (including fiscal decisions). Third, as shown in Figures 7, 8, and 9, between 1988 and 2003, royalties and p_t^* seem to be positively correlated. Finally, the international oil price can in principle affect both the GPP of hydrocarbon-producing provinces and the national GDP (and thus, via the national tax collection, Coparticipation transfers).[35] If this were the case, it would invalidate the exclusion restriction that the instrument affects the dependent variables only via royalties. In Appendix 7.2 we show that this has not been the case. During the period under analysis, changes in the international oil price did not cause, in the sense of Granger, changes in the hydrocarbon-producing provinces' GPP or in the national GDP. We also estimate a fixed effect model to evaluate if contemporary and lagged values of our instrument were correlated with changes in GPP and Coparticipation transfers. We find non-significant results. These results suggest that our instrument affected provincial public consumption and debt only through royalties.

4.2 Data

We use a data set that covers all Argentine provinces from 1988 to 2009. We subtract the component 'Interest Payments' from 'Current Public Expenditures' to create the new variable 'Provincial Public Expenditures', denoted by G. This new variable includes public consumption and transfers to the private sector, but neither public investment nor interest payments. As we mentioned in Section 2.2, this variable represents more than 80 percent of all provincial public outlays.

Regarding the stock of debt, changes in this variable should be equal to the yearly provincial deficit (which includes interest payments). Thus, we use 'Financial Result' (deficits after interest payments) to capture changes in the provincial (stock of) debt. These variables are obtained from *Dirección Nacional de Relaciones Económicas con las Provincias*, the department of the Ministry of Economy that is in charge of the fiscal relations with provincial authorities.[36]

Data on Coparticipation transfers and royalties also comes from this department. Oil and gas production and reserves were obtained from *Anuario de Combustibles*, a yearly pub-

[35] This last impact of p_t^* could be explained by a Dutch Disease causal relationship. But in Argentina, the likelihood of this phenomenon is low because, as we have already mentioned, the exchange rate had been fixed most of the years during period of 1988-2003.

[36] Formerly, *Dirección de Coordinación Fiscal con las Provincias*.

lication from the (former) *Dirección Nacional de Energía y Combustibles*.[37] Oil and gas prices come from the *Instituto Argentino del Petróleo y del Gas*, an NGO that is internationally considered as having the best technical expertise in hydrocarbon industries in Argentina. Finally, provincial GPP is obtained from Porto (2004).

Given the values of all these variables, we construct their contemporaneous and lagged changes. These new variables are all stationary.

We express all money values in thousands of 2004 pesos per capita (unless otherwise stated).

Summary statistics for all variables in the paper are provided in Table 8.

Insert Table 8 here

4.3 Main results

Tables 9 and 10 present the basic estimations of the paper.

Insert Tables 9 and 10 here

In Table 9, we show three different specifications of system (1). In panel (A), we use the entire data set. The results show a significant and economically important positive reaction of public expenditures to the contemporaneous change in Coparticipation transfers and a significant (but economically less important) positive reaction of this outlay to lagged changes in this source of revenue. These results cannot be taken as causal estimates of the impact of changes in Coparticipation transfers on this provincial policy because endogeneity issues are prevalent. In particular, as we have already mentioned, since 2003, discretionary transfers from the national government started to become a very important source of income for many provinces. Therefore, after this date, when a provincial government faced an increase in Coparticipation transfers, it may have reacted by spending a very important fraction of this increase, anticipating that, in case of a posterior decrease of this source of income, it could be compensated or even rescued via discretionary transfers.

We also observe a different reaction to changes in royalties. Facing a contemporaneous increase in this source of revenues, provinces do not modify their public expenditures but do decrease debt in a statistically and economically significant way. The last result is also observed for lagged changes in royalties. Again, these results cannot be considered as proofs of a causal relation because of potential concerns of endogeneity. As we have already mentioned, since 2003, royalties stopped following the evolution of international energy prices;

[37]See http://www.energia.gob.ar/contenidos/verpagina.php?idpagina=3777

instead, they were paid according to domestic hydrocarbon prices, which were set to achieve redistributive and political goals of the national government.

In order to deal with these issues, in panels (B) and (C) we restrict the data set to the period of 1988-2003, when Coparticipation transfers defined by Law 23548 represented on average 94 percent of all intergovernmental transfers and royalties were computed according to international prices. In other words, during this period, both legal regimes ruled intergovernmental fiscal relations in Argentina, with no political intervention from local authorities or from the national government. In panel (B), we do not instrument royalties. We observe that the most important statistically significant estimates are economically different from the previous specification. The reaction of public expenditures to a contemporaneous change in Coparticipation transfers falls by almost 70 percent while the debt reaction to a contemporaneous change in royalties increases by 31 percent. Moreover, provincial authorities decrease debt by 43 centavos when facing a contemporaneous shock in Coparticipation transfers, whereas there was no such reaction under the specification presented in panel (A). Clearly, when we restrict the data set to the years when the possibility to obtain discretionary transfers from the national government was low, provincial authorities have on average a more conservative behavior. Last, in panel (B) we also observe a negative and significant reaction of public expenditures to a contemporaneous increase in royalties, which is not easy to interpret.

Finally, panel (C) presents the estimates derived from our preferred specification when we also instrument royalties. We use the three-stage least squares method (3SLS), as described by Zellner and Theil (1962), to simultaneously account for the endogeneity problem of royalties and the correlation of the error term in decisions of public spending and debt of Argentine provinces.

Table 10 presents the first stage for the contemporaneous change in royalties $\Delta R_{i,t}$. In addition to the change in the instrument $Z_{i,t}$, we add as explanatory variables the lagged changes $\Delta R_{i,t-s}$, for $s \geq 1$ and the other exogenous variables that are included in the second stage. In the table, we observe that the coefficient of the instrument is positive (as predicted) and significant. Moreover, the null hypothesis of weak instruments is rejected in the F-test and, at the one percent level of significance, in the Cragg-Donald statistic.

In panel (C), we obtain a positive and significant estimated response of public expenditures and a negative and significant estimated response of debt to the contemporaneous change in Coparticipation transfers. Both responses are almost identical to those reported in panel (B). On average, and other things being equal, for each one-peso increase in Coparticipation transfers, provincial governments increase current public expenditures by nearly 32 centavos and decrease debt by 43 centavos. The moderate expenditure increase suggests a significant level of expenditure smoothing to shocks in this source of provincial income.

Although this finding stands in sharp contrast to the result obtained by Holtz-Eakin et al. (1994) and Vegh and Vuletin (2015),[38] our estimated coefficients are similar to those found by Dahlberg and Lindström (1998). Public expenditures and debt also react in a statistically and economically significant way when they face an increase in a two-period lagged change in Coparticipation transfers.

Regarding the reactions to a contemporaneous change in royalties, we obtain a statistically non-significant coefficient for public expenditures. But, on the other hand, public debt reacts significantly and negatively, decreasing 75 centavos per peso of increase in this source of revenue. Thus, provincial governments react to contemporaneous changes in royalties mostly by using debt management while leaving public expenditures almost unchanged. Also, facing a one-period lagged change in royalties, provincial authorities react by increasing public expenditures by 20 centavos and decreasing debt by 33 centavos.[39] If we compare these results with those obtained for Coparticipation transfers, we conclude that Argentine provinces that receive income from both sources smooth their fiscal policy more significantly with respect to royalties than to Coparticipation transfers. We discuss the rationale of this result in Section 5.

Finally, once other sources of income are controlled for, the responses of public expenditures or debt to changes in provincial GPP (i.e., the proxy for the local tax base) often have unexpected signs, but when this is the case, they are always economically negligible. Indeed, when the estimated coefficients are statistically significant, changes are below 3 centavos per peso of increase in GPP. These results, some of which are analogous to those obtained by Vegh and Vuletin (2015), reflect in part the very limited capacity of Argentine provinces to react to changes in their tax base. Given such institutional weaknesses, it is difficult to interpret the great gap between the estimated coefficient for changes in provincial private income and the corresponding changes in Coparticipation transfers as evidence of a flypaper effect.

4.4 Robustness checks

We explore the robustness of these results in three different ways.

[38]Still, we have to bear in mind that, despite the fact that Vegh and Vuletin (2015) and this paper both deal with intergovernmental fiscal relations in Argentina, we use different variables (public consumption instead of total expenditures, Coparticipation instead of total transfers), a shorter period of time (1988-2003 in place of 1972-2006), and a different empirical model (a system of equations rather than a single one).

[39]The results for higher-period lagged changes are more difficult to interpret.

4.4.1 Different dynamic specifications

The estimation of the system (1) assumed a three-lag structure of all explanatory variables. Here, we estimate the 3SLS specification of system (1) with different number of lags. The results are shown in Table 11.

Insert Table 11 here

In panel (A), we consider only contemporaneous changes. Some figures are clearly different from those reported in Table 9. Some coefficients that were statistically significant now lose their significance, and others are difficult to interpret (such as the important decrease in public expenditures facing a contemporaneous increase in royalties). In fact, we cannot rely on these results because the R^2 of the first estimated equation is low, and we suspect that we face an omitted variable problem,[40] so the estimations could be inconsistent.

When we move from the specification in panel (A) to those in panels (B) or (C), we first observe an important drop of 281 percent in the Akaike (AIC) statistic, confirming the above-mentioned problem. In specifications in panels (B) and (C), the results and the R^2 change substantially and become closer to those presented in the last specification of Table 9.

4.4.2 Groups of similar provinces

Since we mentioned a couple of reasons to suspect that some provinces have common characteristics that may be driving the results of the basic estimations, it may be worth studying whether these provinces' public expenditures and debt reactions to changes in the independent variables are different from those of the remaining provinces. In order to do that, we estimate different versions of the 3SLS specification of system (1), defining J as a set of provinces with similar characteristics and adding the interaction effect of the dummy

$$\mathbb{1}_i^J = \begin{cases} 1 & \text{if province } i \in J \\ 0 & \text{otherwise} \end{cases}$$

with all independent variables.

Big provinces Given that most provinces' economies are relatively small compared to the Argentine economy, each one considers the evolution of the national tax collection, and a fortiori, Coparticipation transfers as exogenously determined. But because Buenos Aires

[40]Indeed, in all specifications presented in Table 9, many coefficients of the lagged changes of the independent variables are statistically significant.

and CABA have GPPs that represent 35 and 25 percent of the national GDP, respectively, exogeneity cannot be assumed.[41] To a lesser extent, the same critique could be applied to Córdoba and Santa Fe, which are the two next-largest jurisdictions. So, to see if this potential channel of endogeneity is in part driving the results of specification in panel (C) in Table 9, we consider first that

$$J = \{\text{Buenos Aires, CABA, Córdoba, Santa Fe}\}.$$

The results are shown in Table 12.[42]

Insert Table 12 here

As we can see, almost all coefficients of the interaction term between the dummy and changes in Coparticipation transfers are not statistically significant, implying that the reactions to changes in this source of public revenue are not statistically different between these four big provinces and the others.[43]

In both equations, the coefficients of the interactions between the dummy and the contemporaneous change in GPP are statistically significant. This suggests that these big provinces react differently than other provinces when they face changes in the level of economic activity. One possible explanation is that, for these large jurisdictions, local tax receipts are a more relevant source of revenue than for other provinces, and thus, when this source of income changes because of shocks to GPP, it affects public expenditures and debt management more than for smaller provinces. However, even for these important provinces, the economic significance of their reactions to a one peso increase in GPP is very low -their public expenditures increase by 1 centavo and public debt by 2 centavos.

[41] Another reason why Buenos Aires may affect the regressions is the following. As we have already mentioned in footnote 22, since 1992, this province has received an additional amount of Coparticipation transfers in the form of a special, fixed fund called *Fondo de Financiamiento de Programas Sociales en el Conurbano Bonaerense*. In some years, this fund amounted to almost 25 percent of Buenos Aires's Coparticipation transfers. The establishment of this fund was the result of political negotiations between the national government and provincial authorities that took place after Law 23548 was enacted. Thus, these extra funds could generate an endogeneity problem.

[42] The results do not change in any significant way if we incorporate into set J each of these four big provinces, one by one. These estimations are available upon request from the authors.

[43] The exception is the estimated coefficient of the debt reaction to the interaction of the dummy with the contemporaneous change in Coparticipation transfers, which is economically very important but only statistically significant at the 10 percent level, with a p-value of 0.086. Despite this fact, the reaction of these four big provinces to an increase in Coparticipation transfers goes in the same direction as the corresponding reaction of the other provinces.

Finally, the remaining coefficients are very similar to those presented in the last specification in Table 9. We thus conclude that difference in provincial size is not introducing any bias that could modify the results.

Poor provinces As discussed in Section 2, there is a positive correlation between the size of the provincial public sector and the poverty index. Therefore, one may think that poor provinces tend to expend more out of a change in their revenue because their populations have more needs than those of wealthier jurisdictions. To test whether this actually happens, we define a province as poor whenever its poverty index is above 20 percent. Therefore, in this case, the set J is [44]

$$J = \{\text{Chaco, Formosa, Jujuy, Misiones, Santiago del Estero, Tucumán}\}.$$

The results are shown in Tables 13 and 14.

Insert Tables 13 and 14 here

In Table 14, we observe that the instruments $Z_{i,t}$ and $\mathbb{1}_i^J.Z_{i,t}$ performed well in the first stage. We can see in Table 13 that poor provinces behave like wealthier ones. The only difference is that these provinces increase their debt by 11 centavos two periods after a one peso increase in Coparticipation transfers. Poor provinces also decrease public consumption when they face a one period lagged increase in Coparticipation transfers, but this reaction is only significant at the 10 percent level.

Hydrocarbon-producing provinces Although we instrument royalties, we can still suspect that the estimated coefficients $\widehat{\beta}_s^G$ and $\widehat{\beta}_s^D$ in Table 9 may be biased downwards because they capture the average response of all provinces in a situation where only a few of them actually receive royalties. Moreover, we can also argue that hydrocarbon-producing provinces are different from non-oil jurisdictions in terms of their economic, social, and institutional characteristics, which could imply that the response of public expenditures and debt also differs for other revenue sources, including Coparticipation transfers.[45] To evaluate this hypothesis, we now define J to be the set of the eight hydrocarbon-producing provinces.

[44] Salta is also a poor province, with a poverty index of 27.5 percent. But as it is also a hydrocarbon producer, we do not incorporate it into set J because we marginally have a problem of weak instruments when we perform the 3SLS. If we nevertheless consider Salta as a poor province and run the basic regression, results do not change substantially. In Section 4.4.2, we verify whether this particular province can bias our results.

[45] As we mentioned in the Introduction, there is a considerable body of literature on the natural resource curse that postulates the channels through which natural resource abundance could be associated with bad policy and economic performance.

Ideally, we should have proceeded as we did for the case of the big provinces, instrumenting royalties and estimating system (1) by adding the interactions of the dummy with all independent variables. Unfortunately, this is not possible because we face a weak-instrument problem.[46] Therefore, we proceed in a different way. First, we modify the original data set, replacing the values of royalties received in provinces other than the eight hydrocarbon producers with '0'. Then, we estimate system (1) with this new data set, instrumenting royalties for provinces in J. The results are shown in Table 15.

Insert Table 15 here

There, we can observe that all coefficients are almost identical to those of the last specification in Table 9. Thus, we conclude that eliminating royalties from provinces other than the eight hydrocarbon producers does not affect our results.[47] Next, we proceed to estimate the same specification as before, but adding the interaction effect of the dummy that characterizes hydrocarbon-producing provinces.[48] The results are shown in Table 16.

Insert Table 16 here

We do not notice any significant different behavior between these provinces and the other in terms of the Coparticipation transfers. [49] But we observe that a contemporaneous increase in Coparticipation transfers now has no statistically significant effect on public expenditures in hydrocarbon-producing provinces or in the others. This may be due to the fact that the effect of such a change on public expenditures is homogeneous between the two groups of provinces. Thus, when we separate them, we may lose power to find statistically significant coefficients. As before (see Table 9), hydrocarbon-producing provinces show a strong negative reaction in public debt when royalties increase. Finally, there is also a difference with respect to the other provinces because in hydrocarbon-producing provinces both public consumption and debt react to contemporaneous and lagged shocks to GPP. But again, the economic significance of these coefficients is low, which seems to point in the direction of the results found in Table 9.

[46] For provinces that received few royalties, the instruments do not explain the variability of $\Delta R_{i,t}$, and thus the coefficients related to these endogenous variables are inconsistent.

[47] This is not surprising given that, in most of the years, royalties received by hydrocarbon-producing provinces represented more that 97 percent of all royalties.

[48] Proceeding in this way eliminates the abovementioned weak-instrument problem because we do not need to instrument royalties in provinces that do not produce hydrocarbons.

[49] The unique exception concerns the reaction of public debt to a two-period lagged change in Coparticipation transfers. But the difference between the hydrocarbon-producing provinces and the others reinforces the result found in Table 9. Indeed, the former seem to explain the negative reaction.

4.4.3 Specific provinces

Now we examine whether some specific provinces may bias the results obtained in Table 9. We proceed to estimate the 3SLS specification of system (1), but eliminating these particular provinces from the data, one by one. The results are shown in Table 17.

Insert Table 17 here

As we have already mentioned, Argentine provinces face structural difficulties to improve their own tax collection. Figure 2 confirms this assertion, by showing that most provinces raised a fairly constant share of their GPP in own taxes between 1988 and 2003. But some of them were able to increase this share. In particular, Santiago del Estero almost doubled it. As this may bias our estimations, in panel (A) we eliminate this province from the data. All coefficients are almost identical to those obtained in the last specification in Table 9. Thus, we conclude that excluding this province has no impact on the results.

In Section 2, we explained that one percent of the common pool *Masa Coparticipable* was used to finance the provision of *Aportes del Tesoro Nacional* (ATNs), discretionary transfers distributed by the Ministry of Interior. For most provinces, these transfers represented a negligible source of revenue from 1988 to 2003. But this was not the case for all of them. During 1989-1999, La Rioja received, on average, 32 percent of all ATNs (Cetrángolo and Jiménez, 2003). In some years, the ATNs were the same amount as the Coparticipation transfers.[50] As there is a clear concern for endogeneity with this source of revenues, in panel (B) we exclude La Rioja. Again, all coefficients are almost identical to those reported in the last specification of Table 9, implying that La Rioja does not seem to introduce any particular bias in this estimation.

The next two regressions exclude provinces whose Coparticipation coefficients were defined after Law 23548 was enacted in 1988. Panel (C) shows the results without the capital CABA. We observe no important impact on the results, except for the coefficient (significant at the 10 percent level) of the reaction of public expenditures to the one-period lagged change in Coparticipation transfers. This coefficient is economically similar to the coefficient in Table 9. Panel (D) presents the results when we eliminate Tierra del Fuego, which does not modify the most important coefficients of our preferred estimation. In particular, public expenditures still increase by approximately 30 centavos when there is a contemporaneous one-peso increase in Coparticipation transfers, while debt decreases by more than 70 centavos in provinces whose royalties increase by the same amount. The estimated coefficient of the debt reaction to the contemporaneous change in Coparticipation transfers keeps most

[50]This exceptional situation can be explained by the fact that President Carlos Menem (1989-1999) was originally from this province.

of its economic significance, but it becomes marginally non-significant, with a p-value of 0.1058. The other estimated coefficients change more, though. For example, public expenditures and debt reactions to the two-period lagged change in Coparticipation transfers loses statistical and economic significance. These changes can be explained by the fact that Tierra del Fuego has a very small population, and so all of its per capita financial figures exhibit great variability. Thus, excluding this province from the data set may diminish the power to obtain statistically significant coefficients. Regarding royalties, the main difference when we eliminate Tierra del Fuego from the data set concerns the reaction of public expenditures to a contemporaneous increase in this source of income, which is now negative but statistically significant at only the 10 percent level.

Salta is a poor hydrocarbon-producing province, so we could not incorporate it in the group of poor provinces (in Section 4.3.2) because we would potentially face a weak instrument problem in the 3SLS with the corresponding dummy interaction. In order to check whether this particular province may affect our basic estimations, in panel (E) we eliminate Salta from the data set. The estimated coefficients are almost identical to those in Table 9, implying that this province has no particular effect on our preferred regression.

5 Discussion

We have provided consistent evidence on how Argentine provinces modify their public consumption and debt when they face contemporaneous and lagged changes in Coparticipation transfers and hydrocarbon royalties. The first of our main results is that provinces do not react only to contemporaneous changes in their different sources of public income, given that in almost all specifications, some of the estimated coefficients of lagged changes in the exogenous variables are statistically and economically significant. Therefore, not incorporating them in the regressions does matter. We consider this to be indirect evidence that local authorities behave intertemporally. Indeed, public expenditures or debt reactions to lagged changes in public revenues is an optimal policy if, for example, the latter follow autoregressive stochastic processes, as shown in Besfamille et al. (2017).

Second, when we consider the entire data set, provinces spent any increase in Coparticipation transfers by raising public consumption by the same amount. This can be explained by the fact that, after 2003, provincial governments knew that they could obtain discretionary transfers from the national government if needed. But when we restrict the data set to 1988-2003, when the main provincial revenues were determined without any political intervention by the national or by provincial governments, we observe that on average a one peso increase in Coparticipation transfers induced a raise in public consumption by 32 centavos, and a decline of 43 centavos in debt. Thus, provinces smoothed their fiscal policies when they faced shocks to these intergovernmental transfers. These results are robust to controlling for potentially different behavior in some provinces, and even excluding some provinces from the data.

Our third finding is that the reactions of hydrocarbon-producing provinces to shocks depended heavily on the source of income that changed. When the shocks were to Coparticipation transfers, hydrocarbon-producing provinces behaved like the other provinces. But they reacted differently -qualitatively and quantitatively- when faced with a one peso increase in royalties: They channeled much of the adjustment towards a large decrease in debt, approximately 75 centavos, rather than modifying public consumption. In other words, hydrocarbon-producing provinces saved more of the royalties than of the Coparticipation transfers. The economic and statistical significance of this result holds in all specifications.

In the next two sections, we provide two alternative explanations for why hydrocarbon-producing provinces might have acted in this way.

5.1 Volatility of different sources of public income

One explanation for this behavior is that authorities in hydrocarbon-producing provinces may perceive changes in royalties as more volatile than changes in Coparticipation transfers, all else equal. If this were the case, a precautionary savings argument, as pointed out by Vegh and Vuletin (2015), could be made to explain the abovementioned reactions to each type of revenue.[51]

In order to check if this argument holds, we compute the coefficient of variation of both sources of public income for each hydrocarbon-producing province from 1988 to 2003. Table 18 presents the results.

Insert Table 18 here

We confirm that the coefficient of variation is higher for royalties than for Coparticipation transfers, implying that the former are more volatile than the latter.

But as these results concern only unconditional volatility, we can go one step further. Acknowledging that provincial authorities understand that their two main sources of public income follow different random paths (as we have previously assumed), in Appendix 7.3 we estimate different specifications of these stochastic processes and choose the best specifications according to information criteria. We find that royalties follow a mean-reverting

[51] As already mentioned, Cassidy (2018) finds a similar result: In Indonesia, the fiscal responses by subnational governments to transitory changes in oil revenues are less pronounced than the corresponding reaction to a permanent adjustment in a general grant provided by the central government.

process, while Coparticipation transfers evolve according to an autoregressive process of order 2. In Table 20 (see the Appendix), we observe that the estimated coefficient of variation for the error term in the autoregressive equations is higher for royalties than for Coparticipation transfers. This result implies that conditional volatility is also higher for royalties than Coparticipation transfers, which further strengthens the abovementioned argument on precautionary savings.

5.2 Intergenerational concerns and the nonrenewable nature of hydrocarbons

Another explanation for why hydrocarbon-producing provinces spent less of the royalties could be intergenerational considerations and concern over hydrocarbons being nonrenewable resources. Even absent price and geological uncertainty, provincial governments can consider oil and gas reserves as an income-generating asset. In a standard life-cycle model, authorities will use hydrocarbon royalties to maximize the welfare over the expected time horizon, and in the case of a utilitarian provincial government, this maximization would be done over an infinity horizon or number of generations, with no special preference between them. In such a deterministic world, the optimal provincial public consumption path should equal the returns of total net wealth, or the present value of the stream of oil and gas royalties. Figure 10 illustrates this well-known result in a very simple way, when provincial revenues come from the exploitation of a nonrenewable resource with a typical production profile that exhibits different stages of development.

Insert Figure 10 here

We observe that during a mature stage of production, far from the initiation of exploitation but also from depletion (i.e., when $t \in [t_1, t_2]$), provincial governments optimize saving from their royalties.

Of course, optimal planning is more complicated in real life, given price and geological uncertainty. Barnett and Ossowski (2003) explained that the best-known strategy for hydrocarbon-producing governments is a fiscal policy that preserves their hydrocarbon and non-hydrocarbon wealth, which implies that in each period, public consumption should be limited to permanent income -an argument that is familiar from the tax smoothing literature (Barrro, 1979).

Van der Ploeg and Venables (2011) discussed optimal policies for resource-rich developing economies within a model that includes other policy options, such as private capital accumulation and public infrastructure construction. In general, they argued that the optimal use of an increase in government revenues is not to raise public consumption. But they also claim that in low-income countries with scarce capital, there might be a case for skewing consumption towards present generations during the early stages of hydrocarbons production.

However, this particular argument does not apply here. First, according to World Bank criteria, Argentina is considered an upper-middle income country, not a low-income one with scarce capital. Moreover, the period from 1988 to 2003 does not correspond to the early stages of Argentina's oil and gas production, as shown in Figure 11, where we plot the provinces' historical production of hydrocarbons.[52]

Insert Figure 11 here

Chubut was the first province to start producing hydrocarbons, in 1907. In 1918, Neuquén initiated the exploitation of its sites, and by 1950, Mendoza, Salta, and Santa Cruz had followed. Finally, Río Negro and Tierra del Fuego became producers in the late '50s. Clearly, no hydrocarbon-producing province in 1988 was at an initial stage of production.

But is it then possible that these particular provinces were nearing hydrocarbons depletion between 1988 and 2003, when their public consumption should have been supported by interests earned on accumulated assets? We establish that this was not the case by running a depletion index for the years 1970-2003. Each hydrocarbon-producing province j is slotted into the index $DI_{j,t}$, and

$$DI_{j,t} \equiv \frac{AP_{j,t}}{TR_{j,t}} = \frac{\sum_{s=0}^{t} q_{j,s}}{\sum_{s=0}^{t} q_{j,s} + R_{j,t}}$$

is the ratio of accumulated hydrocarbon production $AP_{j,t}$ (from the beginning of exploitation up to year t) to total known reserves in t, $TR_{j,t}$.[53] Figure 12 shows the depletion index $DI_{j,t}$ for the full range of years and the average between 1988 and 2003.[54]

Insert Figure 12 here

Between 1988 and 2003, the depletion index for Neuquén, Salta, and Tierra del Fuego was, on average, below 50 percent. So, we can definitely assert that these three provinces were not close to depletion.

On the other hand, Chubut, La Pampa, Mendoza, Río Negro, and Santa Cruz presented average depletion indexes close to 80 percent. Although such a value seems high and may

[52] In Appendix 7.4, we explain in detail how we build the data depicted in Figures 11 and 12.

[53] Total know reserves $TR_{j,t}$ are known reserves at t, $R_{j,t}$, plus accumulated production up to t, $AP_{j,t}$.

[54] As this figure illustrates an index built using long term data, we present it for a longer period of time to assess its value in perspective. But we could not go back in time because there is no available data for oil and gas reserves before 1970.

suggest an end stage of the production curve, those values are common to countries or regions that have been producing for a long time (because historic production weighs significantly on the index). But that is not to say that these four provinces were not close to depletion. To confirm the actual status, we need to analyze the evolution of their hydrocarbon production during the period under analysis.

Accordingly, for each hydrocarbon-producing province j, we compute the annual reserve replacement rate

$$RRR_{j,t} \equiv \frac{d_{j,t}}{q_{j,t}},$$

which is the ratio between discoveries in year t (i.e., the amount of proved reserves added to the stock), $d_{j,t}$ and production in the same year $q_{j,t}$. A result that is greater than one means that more hydrocarbons are discovered than extracted, so production is not at a depletion stage. The following figure depicts the rate $RRR_{j,t}$ for all hydrocarbon-producing provinces.

Insert Figure 13 here

As we can see, between 1988 and 2003, this rate was above one (indicated by a straight line in the figures) for most of the years. For each hydrocarbon-producing province, then Table 19 formally tests whether the average rate is different from one.

Insert Table 19 here

For these provinces, then we cannot reject the null hypothesis that between 1988 and 2003 their average reserve-replacement rate was equal to one, except for the case of Chubut, where it was greater than this threshold. Despite having an average depletion index near 80 percent, Chubut, Mendoza, Río Negro, and Santa Cruz were not at the final stage of hydrocarbons production.

We conclude that hydrocarbon-producing provinces were, during the years 1988-2003, at a mature stage of production, far from the initiation of exploitation but also from depletion. Therefore, according to the literature that studies the optimal use of revenues from a non-renewable source, it might have been optimal for these provinces to save their royalties.

6 Conclusions

Studying the impact of changes in public revenues on subnational public policies is not easy. From an empirical perspective, researchers face potential concerns over the endogeneity of local tax and nontax revenues. In many developed and developing countries, intergovernmental transfers are usually allocated as a function of observed provincial characteristics or policies' outcomes. In other cases, an important percentage of these transferred funds is discretionally assigned by yearly budget decisions that reflect political negotiations at the congresses or directly between national and subnational authorities.

This paper addresses these issues by focusing on the spending behavior of Argentine provinces during the years 1988-2003. Besides revenue streams from provincial sources, the most important type of transfer that provinces received from the national government came from the Coparticipation tax-sharing regime. Each province's transfer amount was predetermined by a legal, fixed coefficient that did not depend on its characteristics or policies' outcomes. The coefficients did not change during the period under analysis. In addition, we examine provinces' spending behavior of another important source of income for eight provinces, which is hydrocarbon royalties. We looked at royalties because -unlike Coparticipation transfers- royalty income fluctuated wildly (from changing international prices) over the period studied.

These two features provide a unique setting for empirically identifying the impact of shocks to these sources of income on provincial public expenditures and debt, in the absence of major concerns for endogeneity issues. Moreover, we examine whether these reactions depended upon to which source of income had changed.

Our results suggest significant expenditure smoothing in Argentine provinces during the years of 1988-2003, when changes to the tax-sharing transfers and hydrocarbon royalties were exogenous. On average, provinces used 32 centavos out of a one peso increase in their Coparticipation transfers to raise public consumption, and 43 centavos to pay back their debt. Despite the fact that the institutional arrangement that ruled intergovernmental fiscal relations in Argentina seems to be at odds with most criteria accepted by the normative literature on local fiscal federalism, it seems important to stress that our result suggests that when these regulations were persistently enforced, provincial governments adapted to them in a quite rational way. On the top of that, hydrocarbon-producing provinces employ two-thirds of any increase in royalties to repay their debts. These results are robust to different specifications of the basic regressions we conducted. To potentially explain why hydrocarbon-producing provinces save more of the royalties than of the Coparticipation funds, we emphasize the higher volatility of royalties (relative to Coparticipation transfers) and the exhaustible nature of these revenues.

7 Appendix

7.1 The use of discretionary transfers

After 2003, discretionary transfers distributed by the national government represented a higher fraction of provincial incomes than they had previously. But this does not necessarily imply that the allocation of these transfers suffers from endogeneity problems. One could argue that their distribution may have replicated the assignment of Coparticipation transfers. Figure 14 proves that this was not the case, showing the percent of discretionary transfers received (out of the total amount of discretionary transfers allocated to all provinces), for 1993 to 2009.

Insert Figure 14 here

The figure shows that discretionary transfers were not distributed on an equal basis, nor according to the secondary distribution coefficients of Law 23548. Moreover, after 2003, the allocation of discretionary transfers did not follow previous years' patterns. Some provinces received an increasing share of all these transfers, while others saw their share decrease.

7.2 Did the international oil price cause provincial GPP or national GDP?

When we choose the international oil price as one component of the instrument $Z_{i,t}$, we assume that p_t^* affects provincial public expenditures and debt only through royalties and not through other independent variables. To argue that this holds, we test whether Δp_t^* causes, in the sense of Granger, changes in provincial GPP or in the national GDP, between 1988 and 2003.

For each hydrocarbon-producing province, we estimate the regression

$$\Delta Y_{i,t} = \alpha + \sum_{s=0}^{n} \beta_s \Delta p_{t-s}^* + \delta_{i,t}$$

test whether the estimated coefficients $\widehat{\beta}_1 = ... = \widehat{\beta}_n = 0$. In order to choose the specification with the optimal number of lags n^*, we use the Akaike statistic (AIC). Table 20 presents the results.

Insert Table 20 here

For each province, we show n^*, the F-statistic and its p-value. Clearly, in no case is the null hypothesis that Δp_t^* does not cause $\Delta Y_{i,t}$ rejected.

We proceed in a similar way to test whether Δp_t^* does not cause changes in the national GDP. The last row of the table confirms this.

Additionally, we run a fixed effect model to evaluate if contemporary and lagged values of our instrument were correlated with changes in GPP and Coparticipation transfers. Table 21 presents the results.

Insert Table 21 here

Again, we found no significant effects.

7.3 The stochastic processes of royalties and Coparticipation transfers

We empirically estimate specific stochastic processes for royalties and Coparticipation transfers. We use annual data for the period of 1988 - 2003, aggregating (or averaging out) across all provinces. We postulate that these variables evolve according to autoregressive AR(p) processes in first differences. For each type of revenue,[55] we estimate specifications with one, two, and three lags, and we compute the p-value of the Breusch-Godfrey statistic (B-G), corresponding to the highest lag considered. For all specifications, we also evaluate the Akaike statistic (AIC). Table 22 presents the results.

Insert Table 22 here

The first three columns present the results for royalties. According to the Akaike statistic, the specification with one lag should be preferred. Moreover, the p-value of the Breusch-Godfrey statistic shows no serial correlation of errors in all specifications. Given that the coefficient for the first lag is lower than one, changes in royalties follow a mean reverting process. This is consistent with previous results found in the literature about oil prices.[56]

[55] One may wonder whether contemporaneous changes of one variable could be influenced by lagged changes of another variable. In order to verify if this is indeed the case, we estimate a vector autoregressive model with first differences in royalties and Coparticipation transfers. The results, which are available upon request from the authors, show that estimating the two autoregressive equations separately is without any loss of generality.

[56] The fact that oil prices follow an autoregressive process has been accepted in most of the empirical literature on the issue. Pindyck (1999) argues that nonstructural models for energy prices should incorporate mean reversion to a stochastically fluctuating trend line. In particular, these type of models performed well with oil prices. Even in recent literature, where oil prices are modeled as endogenous to supply and demand shocks, the autoregressive behavior of oil prices is further reaffirmed. Casassus et al. (2005) model equilibrium spot and futures oil prices in a general equilibrium production economy. They estimate the model using the simulated method of moments for futures prices and macroeconomic data and find that the resulting equilibrium oil price

The next three columns show the results for Coparticipation transfers. Based on the information conveyed by the Akaike statistic, the specification with two lags should be preferred. No specification shows serial correlation of errors. The two-lag specification implies that changes in these fiscal resources are subject to cyclical fluctuations, as shown by the change in sign between the coefficients of the first and the second lag. This is consistent with the fact that these transfers follow the evolution of the national tax collection, which, in turn, depends on the national GDP. Clearly, the latter is subject to cyclical fluctuations.

In the last row of the table, we compute the coefficient of variation of the error term of the preferred specification of each stochastic process. Royalties present the highest value.

7.4 Data on accumulated provincial production of gas

In order to draw Figure 11, we need the annual provincial production of oil and gas since the beginning of the relevant exploitation. For the historical production of oil, the data can be found in Instituto Argentino del Petróleo (1967) [from 1907 to 1966], in *Anuarios de Combustibles* [from 1967 to 1969] and at the *Instituto Argentino del Petróleo y del Gas* [since 1970]. With these data, accumulated production can be easily computed.

But things get more complicated with respect to gas. Although there is official data for the aggregate (i.e., across all provinces) yearly production of gas since 1913, yearly provincial production is available from only 1950 onwards.[57] To approximate the historical provincial production of gas, we proceed as follows: For each hydrocarbon-producing province j, we obtain from Schiuma et al. (2004) the starting date of gas exploitation $t^g_{j,0}$. Then, we set $q^g_{j,-1} = 0$ as the provincial production of gas in $t^g_{j,0} - 1$ (i.e., one year before the initiation of the exploitation). Finally, we construct the linear interpolation between the provincial production of gas in $t^g_{j,0} - 1$ and in 1950.

To evaluate the accuracy of this approximation, we aggregate the estimated productions between 1913 and 1950 across provinces and compute the accumulated gas production, year by year. We compare these figures with official aggregated data (see *Anuario de Combustibles* 1970-1975). Our simulation underestimates by only 0.83 percent the official accumulated figure in 1970.

exhibits mean-reversion and heteroscedasticity. In a more empirical exercise, Kilian (2009) proposes a structural vector autoregressive model of the global crude oil market that jointly addresses reverse causality from macro aggregates to oil prices and the fact that the oil price is driven by different demand and supply shocks. He shows that both oil supply and demand shocks are mean reverting.

[57] In order to obtain data for the period before 1950, we contacted D. Montamat (former Secretary of Energy of Argentina), O. Secco (former president of the *Instituto Argentino del Petróleo y del Gas*), and M. Schiuma (chief geologist at YPF, the Argentine state-owned energy company). All confirm that this data does not exist.

Finally, to obtain the annual provincial hydrocarbon production (in thousands of m^3 of oil equivalents), we find the sum of oil and gas production, based on their energy content (expressed in BTU of 2003). This data was also used to compute the corresponding accumulated provincial production of hydrocarbons, needed to build the depletion index $DI_{j,t}$.

Tables and Figures

Figure 1: Administrative map of Argentina

Table 1: Basic geographic and socio-economic statistics of Argentine provinces

Province	(1) Area (Sq. km)	(2) Population (Hab.)	(3) Density (Hab/Sq. km)	(4) GPP / GDP (In percent)	(5) Per capita GPP (2004 AR$)	(6) Poverty index (In percent)
Buenos Aires	307,751	13,827,203	44.93	35.06	14,171	13
CABA	203	2,776,138	13,675.56	25.64	51,619	7.1
Catamarca	102,602	334,568	3.26	0.71	11,868	18.4
Chaco	99,633	984,446	9.88	0.96	5,444	27.6
Chubut	224,686	413,237	1.84	1.69	22,852	13.4
Córdoba	165,321	3,066,801	18.55	7.49	13,642	11.1
Corrientes	88,199	930,991	10.56	1.03	6,162	24
Entre Ríos	78,781	1,158,147	14.70	1.98	9,545	14.7
Formosa	72,066	486,559	6.75	0.33	3,813	28
Jujuy	53,219	611,888	11.50	0.59	5,418	26.1
La Pampa	143,440	299,294	2.09	0.89	16,587	9.2
La Rioja	89,680	289,983	3.23	0.72	13,959	17.4
Mendoza	148,827	1,579,651	10.61	2.58	9,124	13.1
Misiones	29,801	965,522	32.40	1.55	8,971	23.5
Neuquén	94,078	474,155	5.04	2.03	23,886	15.5
Río Negro	203,013	552,822	2.72	1.40	14,116	16.1
Salta	155,488	1,079,051	6.94	1.35	7,007	27.5
San Juan	89,651	620,023	6.92	1.00	9,080	14.3
San Luis	76,748	367,933	4.79	1.50	22,810	13
Santa Cruz	243,943	196,958	0.81	1.06	29,998	10.1
Santa Fe	133,007	3,000,701	22.56	7.81	14,555	11.9
Santiago del Estero	136,651	804,457	5.89	0.50	3,488	26.2
Tierra del Fuego	21,571	101,079	4.69	0.45	25,124	15.5
Tucumán	22,524	1,338,523	59.43	1.66	6,954	20.5

Sources: (1): *Instituto Geográfico Militar*. (2),(3) and (6): Censo 2001, *Instituto Nacional de Estadísticas y Censos*. (4) and (5): *Dirección Nacional de Relaciones Económicas con las Provincias*.

Table 2: Size of the public sector in Argentine (as percent of GDP)

Year	National government	Provinces	Municipalities	Consolidated
1988	20.90	9.59	1.68	32.17
1989	21.50	8.64	1.57	31.71
1990	19.00	9.36	2.01	30.37
1991	18.36	10.23	2.45	31.04
1992	17.46	11.46	2.58	31.49
1993	16.35	11.56	2.83	31.71
1994	16.53	11.52	2.81	31.83
1995	17.08	11.74	2.65	32.44
1996	16.17	10.98	2.47	30.54
1997	15.96	10.93	2.54	30.36
1998	15.83	11.46	2.71	30.96
1999	17.59	12.65	2.94	34.23
2000	17.45	12.49	2.84	33.83
2001	18.14	13.42	2.92	35.60
2002	15.00	10.83	2.37	29.11
2003	15.51	10.64	2.41	29.45

Source: *Ministerio de Hacienda*.

Table 3: Size of provincial governments (as percent of GPP)

Province	Size	Province	Size	Province	Size
Buenos Aires	6.33	Formosa	53.42	Salta	16.27
CABA	3.09	Jujuy	27.96	San Juan	17.51
Catamarca	25.45	La Pampa	14.70	San Luis	7.39
Chaco	23.98	La Rioja	20.53	Santa Cruz	17.49
Chubut	10.10	Mendoza	13.19	Santa Fe	7.73
Córdoba	8.23	Misiones	12.35	Santiago del Estero	34.89
Corrientes	17.24	Neuquén	17.22	Tierra del Fuego	17.19
Entre Ríos	15.20	Río Negro	12.88	Tucumán	15.43

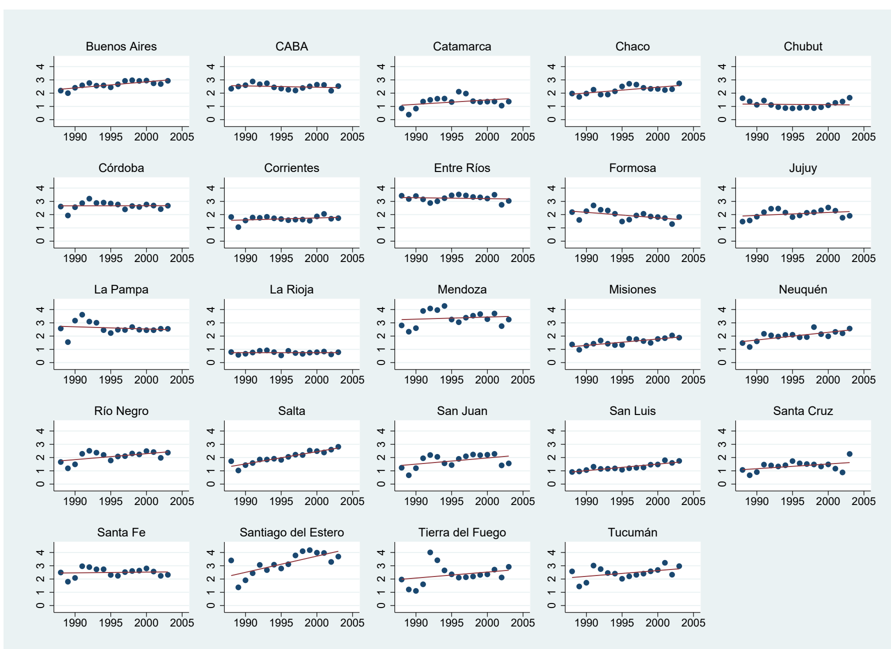
Source: *Dirección Nacional de Relaciones Económicas con las Provincias*.

Table 4: Public consumption and transfers (as percent of total public expenditures)

Province	Public consumption and transfers	Province	Public consumption and transfers
Buenos Aires	89.2	Mendoza	84.2
CABA	88.0	Misiones	75.3
Catamarca	84.1	Neuquén	72.9
Chaco	81.5	Río Negro	81.2
Chubut	73.0	Salta	83.2
Córdoba	86.7	San Juan	78.2
Corrientes	82.3	San Luis	66.0
Entre Ríos	84.3	Santa Cruz	70.8
Formosa	76.6	Santa Fe	88.1
Jujuy	82.5	Santiago del Estero	78.1
La Pampa	73.0	Tierra del Fuego	76.7
La Rioja	82.5	Tucumán	83.7

Source: *Dirección Nacional de Relaciones Económicas con las Provincias*.

Figure 2: Provincial tax collection, by province (as percent of GPP)



Source: *Dirección Nacional de Relaciones Económicas con las Provincias*.

Table 5: Revenue composition, by province (as percent of total public income)

Province	Taxes	Cop. transfers	Royalties	Province	Taxes	Cop. transfers	Royalties
Buenos Aires	46.9	44.0	0.0	Mendoza	26.5	48.6	9.3
CABA	83.6	7.8	0.0	Misiones	14.1	72.8	1.0
Catamarca	6.2	84.5	0.2	Neuquén	13.3	30.6	40.1
Chaco	10.8	81.3	0.0	Río Negro	19.2	58.0	10.4
Chubut	12.9	52.0	23.4	Salta	13.5	66.9	5.0
Córdoba	36.1	55.3	0.0	San Juan	11.5	76.8	0.2
Corrientes	10.5	80.9	0.9	San Luis	16.1	70.7	0.0
Entre Ríos	23.6	65.9	0.9	Santa Cruz	8.4	43.1	29.1
Formosa	4.4	86.6	1.2	Santa Fe	34.9	54.1	0.0
Jujuy	8.7	69.6	0.1	Santiago del Estero	9.0	81.7	0.0
La Pampa	18.1	57.8	2.8	Tierra del Fuego	14.9	45.8	19.6
La Rioja	4.1	59.8	0.0	Tucumán	17.3	73.6	0.0

Source: *Dirección Nacional de Relaciones Económicas con las Provincias*.

Table 6: Per-capita stock of debt, by province (in 2004 AR$)

Province	Debt	Coeff. of variation	Province	Debt	Coeff. of variation
Buenos Aires	449.63	0.91	Mendoza	865.94	0.33
CABA	817.18	0.28	Misiones	772.53	0.83
Catamarca	764.94	1.47	Neuquén	51.16	31.02
Chaco	888	0.89	Río Negro	811.26	2.07
Chubut	449.52	3.57	Salta	527.27	0.64
Córdoba	25.67	19.4	San Juan	403.66	2.66
Corrientes	851.12	0.34	San Luis	230.67	4.36
Entre Ríos	814.85	0.57	Santa Cruz	712.50	1.48
Formosa	1,556.29	1.06	Santa Fe	166.27	1.51
Jujuy	522.83	2.1	Santiago del Estero	296.96	0.78
La Pampa	260.75	1.73	Tierra del Fuego	241.82	9.47
La Rioja	1,578.6	0.57	Tucumán	664.72	0.6

Source: *Dirección Nacional de Relaciones Económicas con las Provincias*.

Figure 3: Argentina's tax-sharing regime *Coparticipación Federal de Impuestos*

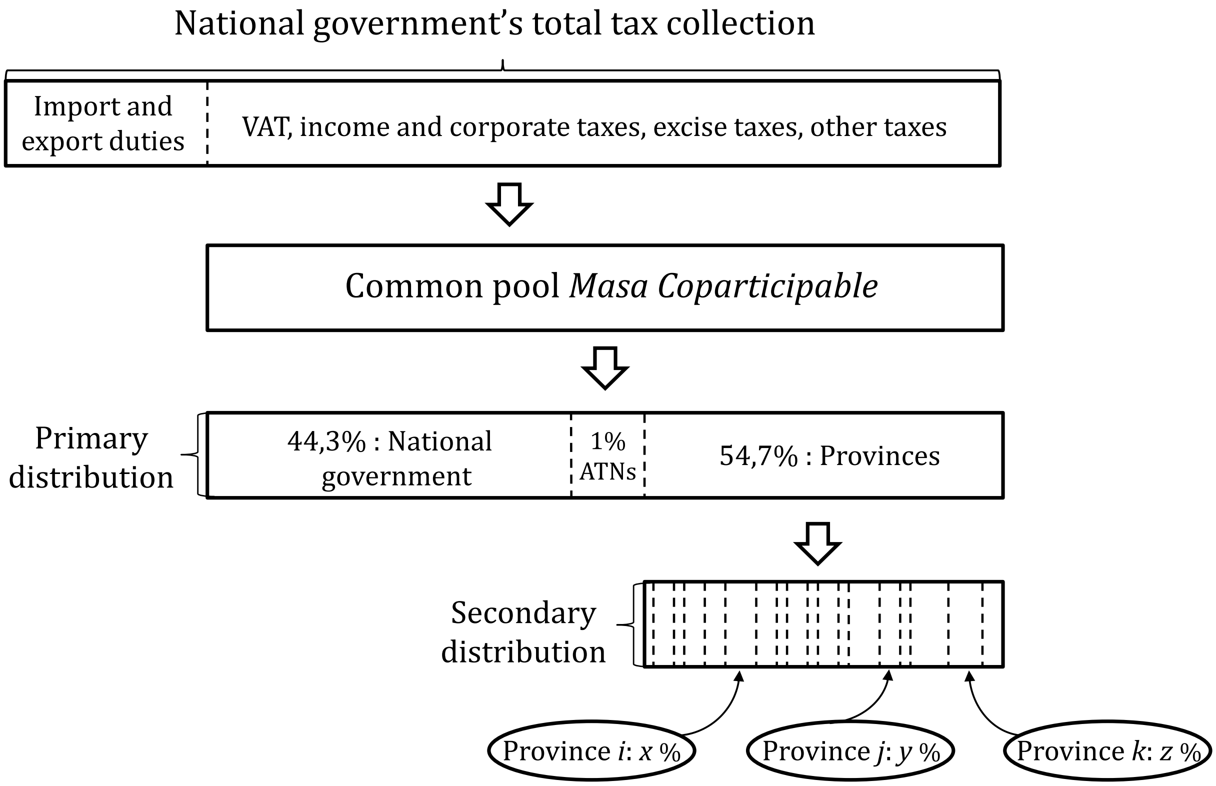
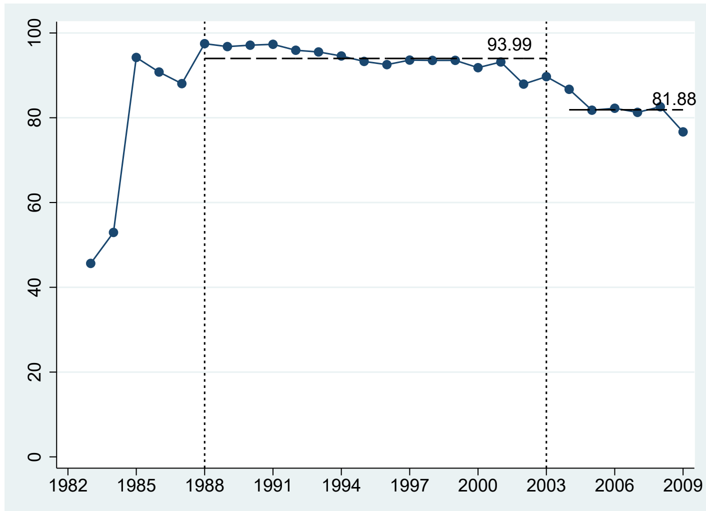


Table 7: Legal shares of the secondary distribution

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

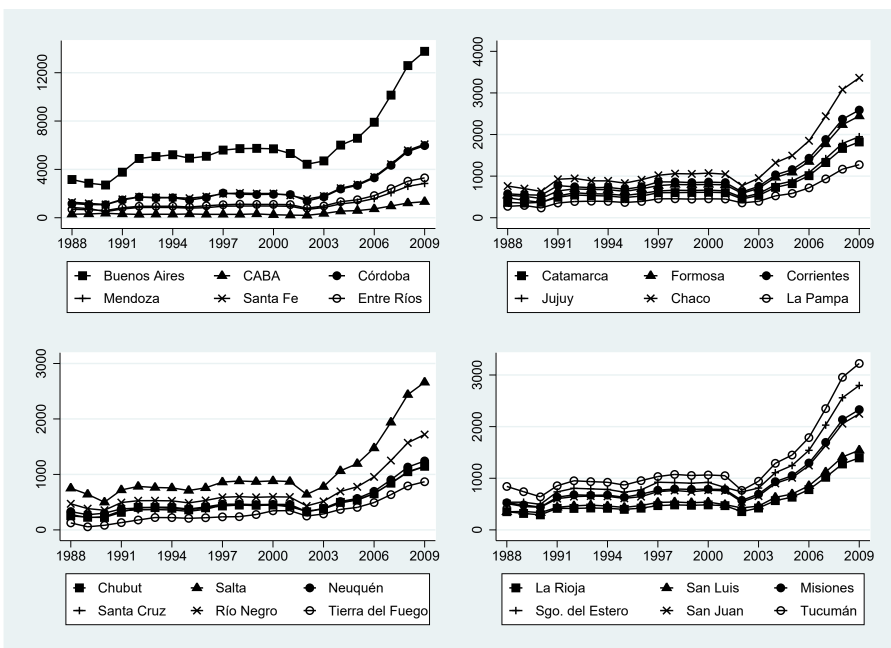
Source: Section 4, Law 23548.

Figure 4: Total Coparticipation transfers (as percent of all intergovernmental transfers)



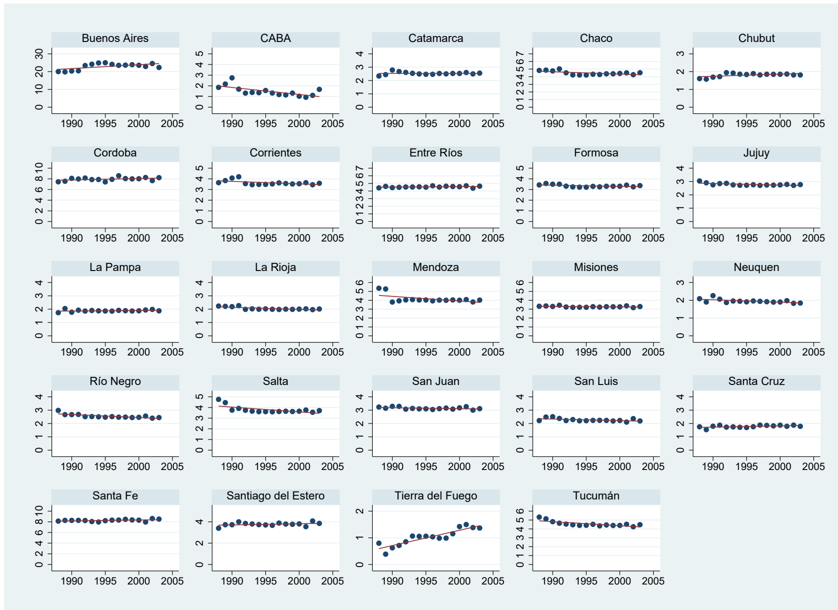
Source: *Dirección Nacional de Relaciones Económicas con las Provincias.*

Figure 5: Coparticipation transfers, by province (in millions of 2004 AR$)



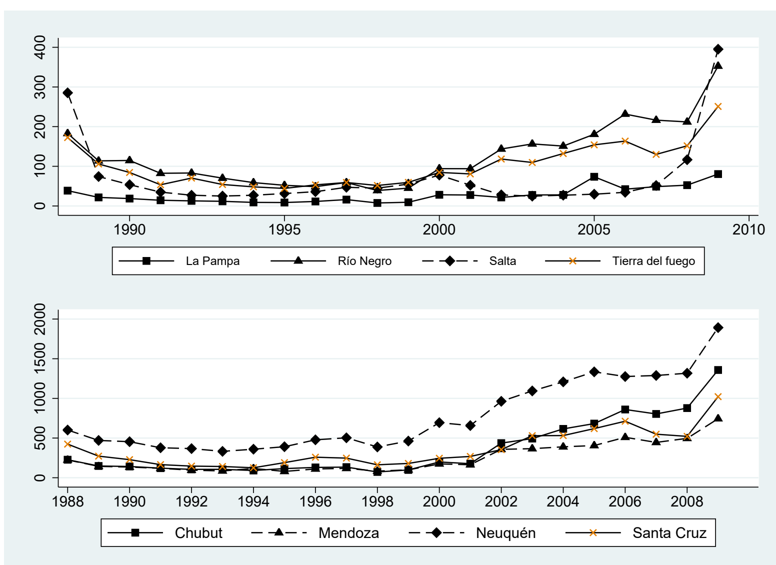
Source: *Dirección Nacional de Relaciones Económicas con las Provincias.*

Figure 6: Coparticipation transfers, by province (as percent of all Coparticipation transfers)



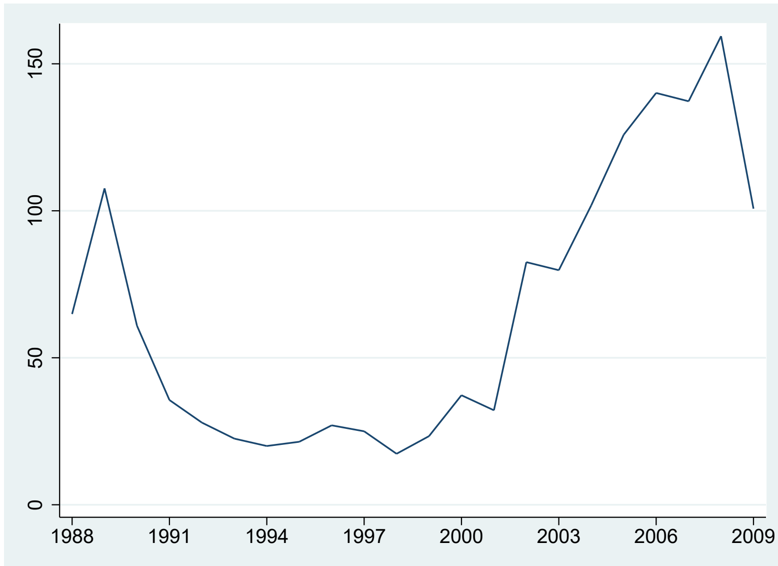
Source: *Dirección Nacional de Relaciones Económicas con las Provincias.*

Figure 7: Hydrocarbon royalties, by province (in millions of 2004 AR$)



Source: *Dirección Nacional de Relaciones Económicas con las Provincias.*

Figure 8: International oil price (in 2004 AR$/m³)



<u>Source</u>: *Instituto Argentino del Petróleo y del Gas*.

Figures 9: Changes in international oil prices and hydrocarbon royalties

<u>Source</u>: *Instituto Argentino del Petróleo y del Gas* and *Dirección Nacional de Relaciones Económicas con las Provincias*.

Table 8: Summary statistics

Variable	Mean	Std. Dev.	Max.	Min.	Observations
$\Delta G_{i,t}$	-0.001	0.23	1.571	-1.164	360
$\Delta D_{i,t}$	0.139	0.285	1.46	-0.602	360
$\Delta TR_{i,t}$	-0.001	0.179	0.636	-1.358	360
$\Delta TR_{i,t-1}$	-0.01	0.181	0.636	-1.358	336
$\Delta TR_{i,t-2}$	0.012	0.159	0.636	-1.358	312
$\Delta TR_{i,t-3}$	0.018	0.163	0.636	-1.358	288
$\Delta R_{i,t}$	-0.006	0.143	0.821	-1.36	360
$\Delta R_{i,t-1}$	-0.009	0.14	0.585	-1.36	336
$\Delta R_{i,t-2}$	-0.017	0.134	0.479	-1.36	312
$\Delta R_{i,t-3}$	-0.017	0.139	0.479	-1.36	288
$\Delta Y_{i,t}$	0.088	1.687	8.688	-13.107	360
$\Delta Y_{i,t-1}$	0.029	1.72	8.688	-13.107	336
$\Delta Y_{i,t-2}$	0.086	1.759	8.688	-13.107	312
$\Delta Y_{i,t-3}$	0.202	1.766	8.688	-13.107	288
$q^o_{i,1987}$ (in m^3)	3,059,652	2,174,131.55	5,855,261	0	24
p^*_t(in 2004 AR$/$m^3$)	42.83	27.52	107.62	17.35	16

Note: All variables are in thousand 2004 AR$ per capita (except otherwise stated)

Table 9: Basic estimations

	(A) SUR (1988-2009)		(B) SUR (1988-2003)		(C) 3SLS (1988-2003)	
Variables	$\Delta G_{i,t}$	$\Delta D_{i,t}$	$\Delta G_{i,t}$	$\Delta D_{i,t}$	$\Delta G_{i,t}$	$\Delta D_{i,t}$
$\Delta TR_{i,t}$	1.081*** (0.098)	−0.136 (0.1)	0.31*** (0.109)	−0.426*** (0.133)	0.317*** (0.111)	−0.432*** (0.135)
$\Delta TR_{i,t-1}$	0.237*** (0.099)	0.257** (0.102)	0.136 (0.096)	0.064 (0.117)	0.142 (0.098)	0.06 (0.119)
$\Delta TR_{i,t-2}$	0.265*** (0.095)	0.051 (0.98)	0.282** (0.118)	−0.349** (0.144)	0.289** (0.12)	−0.354** (0.146)
$\Delta TR_{i,t-3}$	−0.026 (0.083)	0.246*** (0.085)	−0.056 (0.093)	−0.06 (0.113)	−0.046 (0.096)	−0.067 (0.117)
$\Delta R_{i,t}$	−0.042 (0.073)	−0.553*** (0.074)	−0.282*** (0.099)	−0.717*** (0.121)	−0.232 (0.163)	−0.752*** (0.199)
$\Delta R_{i,t-1}$	−0.171* (0.095)	−0.649*** (0.097)	0.207** (0.104)	−0.328*** (0.127)	0.204* (0.105)	−0.326*** (0.127)
$\Delta R_{i,t-2}$	0.185* (0.097)	−0.319*** (0.1)	−0.386*** (0.126)	−0.385** (0.154)	−0.379*** (0.128)	−0.39** (0.156)
$\Delta R_{i,t-3}$	0.492*** (0.089)	0.571*** (0.091)	0.296*** (0.094)	0.491*** (0.114)	0.286*** (0.097)	0.498*** (0.118)
$\Delta Y_{i,t}$	0.013* (0.008)	−0.018** (0.008)	−0.018** (0.007)	−0.016* (0.009)	−0.018** (0.008)	−0.017* (0.009)
$\Delta Y_{i,t-1}$	0.026*** (0.007)	0.017** (0.007)	0.016** (0.007)	0.009 (0.008)	0.016** (0.007)	0.009 (0.008)
$\Delta Y_{i,t-2}$	−0.012* (0.007)	−0.0 (0.007)	−0.019*** (0.007)	−0.017** (0.008)	−0.018*** (0.007)	−0.017** (0.008)
$\Delta Y_{i,t-3}$	−0.014* (0.007)	−0.005 (0.007)	−0.001 (0.007)	−0.028*** (0.008)	−0.001 (0.007)	−0.028*** (0.008)
Observations	432	432	288	288	288	288
R^2	0.709	0.504	0.537	0.561	0.536	0.561
AIC[a]					−360.61	

Standard errors in parenthesis. All regressions include provincial and year fixed effects.

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

[a] Akaike statistic. [b] F - statistic for excluded instruments.

[c] Cragg-Donald statistic.

Table 10: First stage of 3SLS

Variables	$\Delta R_{i,t}$
$\Delta Z_{i,t}$	0.657*** (0.055)
$\Delta TR_{i,t}$	−0.147*** (0.056)
$\Delta TR_{i,t-1}$	−0.078 (0.049)
$\Delta TR_{i,t-2}$	−0.062 (0.061)
$\Delta TR_{i,t-3}$	−0.223*** (0.047)
$\Delta R_{i,t-1}$	0.125** (0.054)
$\Delta R_{i,t-2}$	−0.316*** (0.075)
$\Delta R_{i,t-3}$	-0.082 (0.053)
$\Delta Y_{i,t}$	0.003 (0.004)
$\Delta Y_{i,t-1}$	−0.001 (0.004)
$\Delta Y_{i,t-2}$	−0.004 (0.003)
$\Delta Y_{i,t-3}$	−0.002 (0.004)
Observations	288
R^2	0.583
F^b	140.9
Cragg-Donald[c]	140.9

Table 11: 3SLS specification with different number of lags

	(A)		(B)		(C)	
Variables	$\Delta G_{i,t}$	$\Delta D_{i,t}$	$\Delta G_{i,t}$	$\Delta D_{i,t}$	$\Delta G_{i,t}$	$\Delta D_{i,t}$
$\Delta TR_{i,t}$	0.637^{***} (0.133)	-0.057 (0.13)	0.342^{***} (0.098)	-0.091 (0.116)	0.262^{***} (0.101)	-0.23^{*} (0.122)
$\Delta TR_{i,t-1}$			0.370^{***} (0.075)	-0.038 (0.09)	0.137 (0.098)	-0.088 (0.117)
$\Delta TR_{i,t-2}$					-0.114 (0.088)	-0.295^{***} (0.105)
$\Delta R_{i,t}$	-0.897^{*} (0.378)	-0.435 (0.368)	-0.166 (0.185)	-0.552^{***} (0.220)	0.005 (0.161)	-0.450^{**} (0.193)
$\Delta R_{i,t-1}$			0.24^{**} (0.097)	-0.250^{**} (0.115)	0.145 (0.109)	-0.262^{**} (0.131)
$\Delta R_{i,t-2}$					-0.350^{***} (0.1)	-0.207^{*} (0.12)
$\Delta Y_{i,t}$	0.017^{*} (0.009)	0.00 (0.009)	-0.002 (0.007)	0.004 (0.009)	-0.005 (0.007)	-0.002 (0.009)
$\Delta Y_{i,t-1}$			0.005 (0.007)	-0.001 (0.008)	0.005 (0.07)	0.000 (0.009)
$\Delta Y_{i,t-2}$					-0.025^{***} (0.007)	-0.009 (0.008)
Observations	360	360	336	336	312	312
R^2	0.175	0.488	0.494	0.511	0.536	0.519
AIC[a]	-81.8		-311.74		-313.84	

Standard errors in parenthesis. All regressions include provincial and year fixed effects.
* Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level
[a] Akaike statistic.

Table 12: Big provinces

	3SLS			3SLS	
Variables	$\Delta G_{i,t}$	$\Delta D_{i,t}$	Variables	$\Delta G_{i,t}$	$\Delta D_{i,t}$
$\Delta TR_{i,t}$	0.327^{***} (0.111)	-0.438^{***} (0.134)	$\Delta R_{i,t-2}$	-0.390^{***} (0.128)	-0.412^{***} (0.155)
$\mathbb{1}_i^J.\Delta TR_{i,t}$	-0.291 (0.444)	-0.945^{*} (0.536)	$\Delta R_{i,t-3}$	0.291^{***} (0.097)	0.496^{***} (0.117)
$\Delta TR_{i,t-1}$	0.15 (0.099)	0.07 (0.119)	$\Delta Y_{i,t}$	-0.024^{***} (0.009)	-0.023^{**} (0.011)
$\mathbb{1}_i^J.\Delta TR_{i,t-1}$	-0.177 (0.416)	-0.161 (0.501)	$\mathbb{1}_i^J.\Delta Y_{i,t}$	0.034^{**} (0.016)	0.044^{**} (0.019)
$\Delta TR_{i,t-2}$	-0.241^{*} (0.124)	-0.422^{***} (0.149)	$\Delta Y_{i,t-1}$	0.017^{**} (0.008)	0.013 (0.01)
$\mathbb{1}_i^J.\Delta TR_{i,t-2}$	0.203 (0.505)	0.443 (0.609)	$\mathbb{1}_i^J.\Delta Y_{i,t-1}$	-0.025 (0.018)	-0.037^{*} (0.021)
$\Delta TR_{i,t-3}$	-0.06 (0.102)	-0.074 (0.122)	$\Delta Y_{i,t-2}$	-0.019^{**} (0.008)	-0.012 (0.009)
$\mathbb{1}_i^J.\Delta TR_{i,t-3}$	-0.338 (0.511)	-0.673 (0.616)	$\mathbb{1}_i^J.\Delta Y_{i,t-2}$	0.006 (0.018)	-0.007 (0.022)
$\Delta R_{i,t}$	-0.246 (0.165)	-0.764^{***} (0.199)	$\Delta Y_{i,t-3}$	-0.002 (0.008)	-0.025^{***} (0.009)
$\Delta R_{i,t-1}$	0.198^{*} (0.104)	-0.313^{***} (0.126)	$\mathbb{1}_i^J.\Delta Y_{i,t-3}$	0.012 (0.015)	0.007 (0.019)
Observations	288	288			
R^2	0.545	0.579			

Standard errors in parenthesis. All regressions include provincial and year fixed effects.
* Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level
The interactions between the dummy $\mathbb{1}_i^J$ and $\Delta R_{i,t-s}$, $s = 0, 1, 2, 3$ are dropped because, as the four biggest provinces never received royalties, these interactions are equal to the vector **0**, and thus cannot be instrumented.

Table 13: Poor provinces, 3SLS

Variables	$\Delta G_{i,t}$	$\Delta D_{i,t}$	Variables	$\Delta G_{i,t}$	$\Delta D_{i,t}$
$\Delta TR_{i,t}$	0.319^{***} (0.111)	-0.467^{***} (0.137)	$\Delta R_{i,t-2}$	-0.357^{***} (0.129)	-0.386^{**} (0.158)
$\mathbb{1}_i^J.\Delta TR_{i,t}$	-0.279 (0.197)	0.111 (0.242)	$\mathbb{1}_i^J.\Delta R_{i,t-2}$	2.676 (5.515)	0.061 (6.776)
$\Delta TR_{i,t-1}$	0.153 (0.099)	0.063 (0.122)	$\Delta R_{i,t-3}$	0.291^{***} (0.097)	0.507^{***} (0.12)
$\mathbb{1}_i^J.\Delta TR_{i,t-1}$	-0.117 (0.190)	0.037 (0.233)	$\mathbb{1}_i^J.\Delta R_{i,t-3}$	3.902 (5.009)	-1.552 (6.154)
$\Delta TR_{i,t-2}$	0.262^{**} (0.123)	-0.463^{***} (0.151)	$\Delta Y_{i,t}$	-0.022^{***} (0.008)	-0.016^{*} (0.009)
$\mathbb{1}_i^J.\Delta TR_{i,t-2}$	0.051 (0.230)	0.574^{**} (0.282)	$\mathbb{1}_i^J.\Delta Y_{i,t}$	0.044 (0.059)	0.066 (0.073)
$\Delta TR_{i,t-3}$	-0.017 (0.097)	-0.064 (0.120)	$\Delta Y_{i,t-1}$	0.013^{*} (0.007)	0.008 (0.009)
$\mathbb{1}_i^J.\Delta TR_{i,t-3}$	-0.203 (0.211)	0.092 (0.260)	$\mathbb{1}_i^J.\Delta Y_{i,t-1}$	-0.127^{*} (0.072)	-0.086 (0.089)
$\Delta R_{i,t}$	-0.194 (0.162)	-0.773^{***} (0.2)	$\Delta Y_{i,t-2}$	-0.018^{***} (0.007)	-0.023^{***} (0.008)
$\mathbb{1}_i^J.\Delta R_{i,t}$	6.91 (13.837)	-11.023 (17)	$\mathbb{1}_i^J.\Delta Y_{i,t-2}$	0.038 (0.065)	-0.084 (0.08)
$\Delta R_{i,t-1}$	0.199^{*} (0.105)	-0.324^{**} (0.129)	$\Delta Y_{i,t-3}$	-0.001 (0.007)	-0.033^{***} (0.008)
$\mathbb{1}_i^J.\Delta R_{i,t-1}$	-0.521 (6.389)	0.018 (7.850)	$\mathbb{1}_i^J.\Delta Y_{i,t-3}$	0.028 (0.053)	-0.018 (0.066)
			Observations	288	288
			R^2	0.553	0.57

Standard errors in parenthesis.

All regressions include provincial and year fixed effects.

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

Table 14: Poor provinces, first stage of 3SLS

Variables	$\Delta R_{i,t}$	$\mathbb{1}_i^J.\Delta R_{i,t}$	Variables	$\Delta R_{i,t}$	$\mathbb{1}_i^J.\Delta R_{i,t}$
$\Delta Z_{i,t}$	0.656^{***} (0.147)	0.000 (0.000)	$\Delta R_{i,t-2}$	0.30 (0.201)	-0.001 (0.00)
$\mathbb{1}_i^J.\Delta Z_{i,t}$	-0.393 (0.429)	0.246^{***} (0.03)	$\mathbb{1}_i^J.\Delta R_{i,t-2}$	0.931 (0.694)	0.192 (0.128)
$\Delta TR_{i,t}$	-0.151^{*} (0.087)	-0.001 (0.001)	$\Delta R_{i,t-3}$	-0.084 (0.121)	-0.000 (0.00)
$\mathbb{1}_i^J.\Delta TR_{i,t}$	0.236^{***} (0.084)	-0.000 (0.004)	$\mathbb{1}_i^J.\Delta R_{i,t-3}$	0.339 (0.676)	-0.038 (0.098)
$\Delta TR_{i,t-1}$	-0.079 (0.078)	-0.000 (0.000)	$\Delta Y_{i,t}$	0.005 (0.007)	-0.000 (0.000)
$\mathbb{1}_i^J.\Delta TR_{i,t-1}$	0.125^{**} (0.055)	-0.005^{**} (0.002)	$\mathbb{1}_i^J.\Delta Y_{i,t}$	-0.022^{*} (0.011)	0.000 (0.001)
$\Delta TR_{i,t-2}$	-0.063 (0.081)	-0.000 (0.001)	$\Delta Y_{i,t-1}$	-0.000 (0.005)	-0.000 (0.00)
$\mathbb{1}_i^J.\Delta TR_{i,t-2}$	0.042 (0.055)	-0.001 (0.003)	$\mathbb{1}_i^J.\Delta Y_{i,t-1}$	0.006 (0.14)	0.002^{**} (0.001)
$\Delta TR_{i,t-3}$	-0.241^{***} (0.07)	0.000 (0.00)	$\Delta Y_{i,t-2}$	-0.003 (0.007)	-0.000 (0.00)
$\mathbb{1}_i^J.\Delta TR_{i,t-3}$	0.129^{***} (0.048)	0.004 (0.003)	$\mathbb{1}_i^J.\Delta Y_{i,t-2}$	-0.001 (0.01)	-0.002^{***} (0.001)
$\Delta R_{i,t-1}$	0.127 (0.12)	0.000 (0.00)	$\Delta Y_{i,t-3}$	-0.001 (0.006)	0.000 (0.000)
$\mathbb{1}_i^J.\Delta R_{i,t-1}$	-0.16 (0.836)	0.117 (0.087)	$\mathbb{1}_i^J.\Delta Y_{i,t-3}$	-0.009 (0.011)	-0.000 (0.001)
			Observations	288	288
			R^2	0.597	0.402
			F^a	10.91	35.65

Standard errors in parenthesis.

All regressions include provincial and year fixed effects.

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

[a] $F-$statistic for excluded instruments.

Table 15: Eliminating royalties from non-hydrocarbon producer provinces

Variables	$\Delta G_{i,t}$	$\Delta D_{i,t}$
$\Delta TR_{i,t}$	0.316*** (0.111)	–0.434*** (0.135)
$\Delta TR_{i,t-1}$	0.142 (0.097)	0.064 (0.119)
$\Delta TR_{i,t-2}$	0.289** (0.12)	−0.352*** (0.146)
$\Delta TR_{i,t-3}$	−0.046 (0.096)	−0.066 (0.118)
$\Delta R_{i,t}$	−0.232 (0.163)	−0.748*** (0.199)
$\Delta R_{i,t-1}$	0.204* (0.104)	−0.321** (0.127)
$\Delta R_{i,t-2}$	−0.382*** (0.128)	−0.391*** (0.156)
$\Delta R_{i,t-3}$	0.284*** (0.097)	0.495*** (0.118)
$\Delta Y_{i,t}$	−0.018** (0.008)	−0.017* (0.009)
$\Delta Y_{i,t-1}$	0.016** (0.007)	0.009 (0.008)
$\Delta Y_{i,t-2}$	−0.018*** (0.007)	−0.017** (0.008)
$\Delta Y_{i,t-3}$	−0.001 (0.007)	−0.028*** (0.008)
Observations	288	288
R^2	0.537	0.56

Table 16: Hydrocarbon producer provinces

Variables	$\Delta G_{i,t}$	$\Delta D_{i,t}$
$\Delta TR_{i,t}$	0.218 (0.164)	−0.622*** (0.197)
$\mathbb{1}_i^J.\Delta TR_{i,t}$	0.157 (0.171)	0.257 (0.206)
$\Delta TR_{i,t-1}$	0.126 (0.138)	0.215 (0.166)
$\mathbb{1}_i^J.\Delta TR_{i,t-1}$	0.093 (0.145)	−0.111 (0.174)
$\Delta TR_{i,t-2}$	0.398*** (0.15)	−0.002 (0.18)
$\mathbb{1}_i^J.\Delta TR_{i,t-2}$	−0.213 (0.172)	−0.424** (0.207)
$\Delta TR_{i,t-3}$	0.074 (0.149)	0.133 (0.179)
$\mathbb{1}_i^J.\Delta TR_{i,t-3}$	−0.031 (0.146)	−0.223 (0.175)
$\Delta R_{i,t}$	−0.209 (0.187)	−0.807*** (0.225)
$\Delta R_{i,t-1}$	0.174 (0.112)	−0.382*** (0.135)
$\Delta R_{i,t-2}$	−0.401*** (0.145)	−0.408** (0.175)
$\Delta R_{i,t-3}$	0.318*** (0.103)	0.511*** (0.124)
$\Delta Y_{i,t}$	0.01 (0.012)	0.006 (0.014)
$\mathbb{1}_i^J.\Delta Y_{i,t}$	−0.035** (0.014)	−0.027 (0.017)
$\Delta Y_{i,t-1}$	−0.014 (0.014)	−0.016 (0.017)
$\mathbb{1}_i^J.\Delta Y_{i,t-1}$	0.038** (0.016)	0.037* (0.019)
$\Delta Y_{i,t-2}$	−0.005 (0.014)	−0.019 (0.017)
$\mathbb{1}_i^J.\Delta Y_{i,t-2}$	−0.013 (0.016)	0.017 (0.019)
$\Delta Y_{i,t-3}$	0.008 (0.012)	−0.036** (0.015)
$\mathbb{1}_i^J.\Delta Y_{i,t-3}$	−0.013 (0.014)	0.016 (0.017)
Observations	288	288
R^2	0.554	0.587

Standard errors in parenthesis. All regressions include provincial and year fixed effects.
* Significant at 10% level. **Significant at 5% level. ***Significant at 1% level
In Table 15, the interactions between the dummy $\mathbb{1}_i^J$ and $\Delta R_{i,t-s}$, $s = 0, 1, 2, 3$ are dropped because they are colinear with the latter.

Table 17: Eliminating specific provinces

	(A)		(B)		(C)		(D)		(E)	
Variables	$\Delta G_{i,t}$	$\Delta D_{i,t}$	$\Delta G_{i,t}$	$\Delta D_{i,t}$	$\Delta G_{i,t}$	$\Delta D_{i,t}$	$\Delta G_{i,t}$	$\Delta D_{i,t}$	$\Delta G_{i,t}$	$\Delta D_{i,t}$
$\Delta TR_{i,t}$	0.299*** (0.114)	−0.456*** (0.138)	0.314*** (0.115)	−0.412*** (0.136)	0.336*** (0.114)	−0.458*** (0.139)	0.32** (0.132)	−0.304 (0.188)	0.311*** (0.113)	−0.414*** (0.136)
$\Delta TR_{i,t-1}$	0151 (0.101)	0.066 (0.122)	0.124 (0.103)	0.017 (0.122)	0.184* (0.101)	0.114 (0.123)	0.085 (0.119)	0.065 (0.17)	0.137 (0.1)	0.057 (0.12)
$\Delta TR_{i,t-2}$	0.274*** (0.123)	−0.388*** (0.149)	0.275** (0.127)	−0.353** (0.161)	0.243* (0.126)	−0.451*** (0.153)	0.157 (0.125)	−0.143 (0.179)	0.287** (0.122)	−0.346** (0.147)
$\Delta TR_{i,t-3}$	−0.047 (0.098)	−0.085 (0.120)	−0.054 (0.099)	−0.073 (0.118)	−0.017 (0.102)	−0.043 (0.124)	0.348*** (0.112)	0.334** (0.16)	−0.051 (0.099)	−0.082 (0.119)
$\Delta R_{i,t}$	−0.22 (0.166)	−0.757*** (0.202)	−0.237 (0.165)	−0.742*** (0.196)	−0.245 (0.165)	−0.776*** (0.201)	−0.26* (0.147)	−0.732*** (0.210)	−0.228 (0.167)	−0.75*** (0.2)
$\Delta R_{i,t-1}$	0.204* (0.106)	−0.337*** (0.129)	0.186* (0.106)	−0.328*** (0.126)	0.191* (0.105)	−0.341*** (0.128)	0.227** (0.093)	−0.12 (0.133)	0.204* (0.107)	−0.334*** (0.128)
$\Delta R_{i,t-2}$	−0.371*** (0.130)	−0.388** (0.158)	−0.382*** (0.13)	−0.4*** (0.154)	−0.408*** (0.13)	−0.427*** (0.158)	−0.424*** (0.116)	−0.317* (0.166)	−0.379*** (0.131)	−0.386** (0.157)
$\Delta R_{i,t-3}$	0.28*** (0.099)	0.489*** (0.12)	0.29*** (0.099)	0.478*** (0.117)	0.306*** (0.098)	0.508*** (0.119)	0.29*** (0.09)	0.536*** (0.129)	0.287*** (0.1)	0.518*** (0.12)
$\Delta Y_{i,t}$	−0.018** (0.008)	−0.015 (0.009)	−0.017** (0.008)	−0.017* (0.009)	−0.025*** (0.009)	−0.026** (0.011)	0.000 (0.008)	0.009 (0.011)	−0.018** (0.008)	−0.014 (0.009)
$\Delta Y_{i,t-1}$	0.015** (0.007)	0.009 (0.008)	0.015** (0.007)	0.007 (0.008)	0.016** (0.008)	0.01 (0.01)	−0.009 (0.009)	−0.01 (0.012)	0.015** (0.007)	0.009 (0.008)
$\Delta Y_{i,t-2}$	−0.019** (0.007)	−0.018** (0.008)	−0.02*** (0.007)	−0.018** (0.008)	−0.019** (0.008)	−0.014 (0.01)	0.000 (0.009)	−0.005 (0.013)	−0.019*** (0.007)	−0.019** (0.008)
$\Delta Y_{i,t-3}$	−0.002 (0.007)	−0.029*** (0.008)	−0.002 (0.007)	−0.027*** (0.008)	−0.002 (0.008)	−0.027*** (0.009)	0.029** (0.008)	−0.011 (0.012)	−0.001 (0.007)	−0.028*** (0.008)
Observations	276	276	276	276	276	276	276	276	276	276
R^2	0.536	0.559	0.528	0.573	0.546	0.573	0.595	0.571	0.535	0.571

Standard errors in parenthesis.

All regressions include provincial and year fixed effects.

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

Table 18: Coefficient of variation by source of income, by province

Province	Coparticipation transfers	Royalties
Chubut	0.2088	0.69
La Pampa	0.1761	0.5061
Mendoza	0.1492	0.5795
Neuquén	0.1535	0.4102
Río Negro	0.146	0.4748
Salta	0.1386	1.0886
Santa Cruz	0.1965	0.447
Tierra del Fuego	0.3903	0.4394

Source: Own calculations.

Figure 10: Optimal public consumption with a nonrenewable source of income

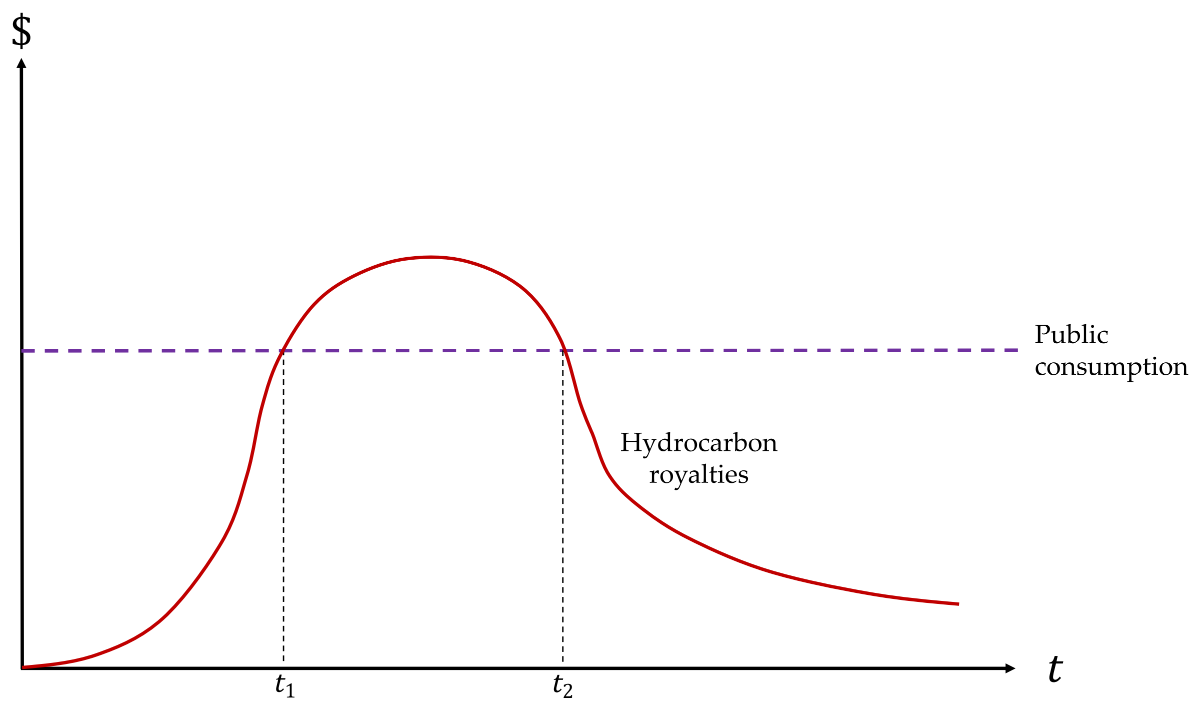
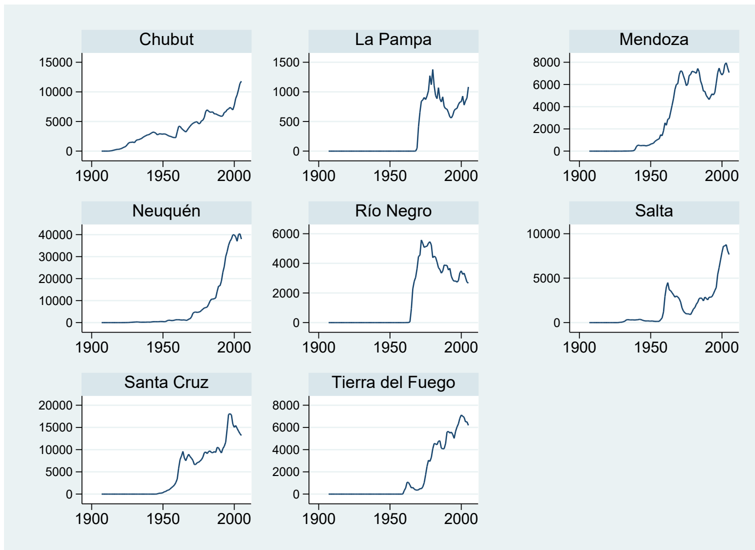
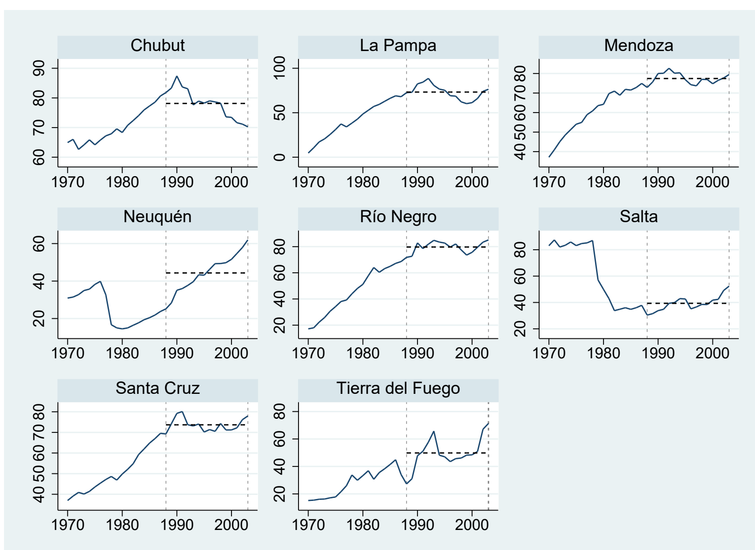


Figure 11: Historical production of hydrocarbons, by province (in thousand of m³ of oil equivalents)



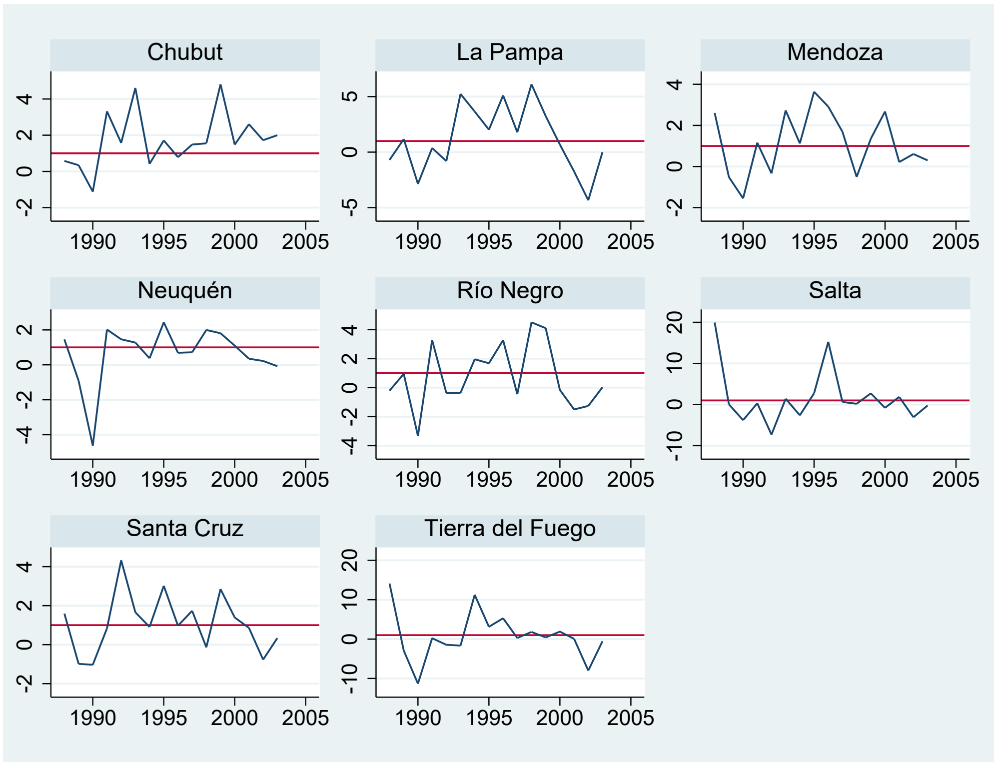
Source: Instituto Argentino del Petróleo (1967), *Anuario de Combustibles*, *Instituto Argentino del Petróleo y del Gas* and own calculations.

Figure 12: Index of hydrocarbons depletion, by province (in percent)



Source: *Anuario de Combustibles* and own calculations.

Figure 13: Reserve replacement rate, by province

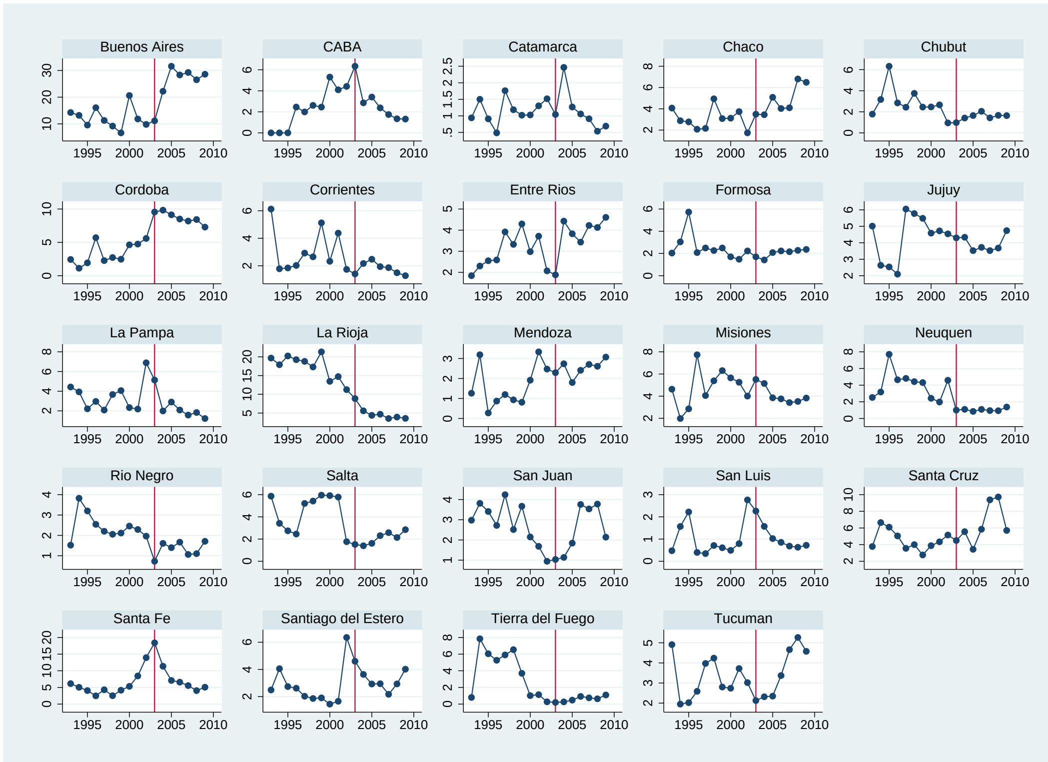


Source: *Anuario de Combustibles* and own calculations.

Table 19: Test of difference between average reserve replacement rate and one, by province

Province	Average $RRR_{j,t}$	p - value
Chubut	1.744	0.071
La Pampa	1.185	0.806
Mendoza	1.132	0.728
Neuquén	0.644	0.404
Río Negro	0.762	0.671
Salta	1.702	0.685
Santa Cruz	1.098	0.793
Tierra del Fuego	0.789	0.893

Figure 14: Discretionary transfers, by province (as percent of all discretionary transfers)



Source: Artana et al. (2012)

Table 20: Granger causality test

Province	n^*	$F-$statistic	p - value
Chubut	2	1.12	0.3719
La Pampa	2	1.69	0.2435
Mendoza	2	1.81	0.2245
Neuquén	2	1.64	0.2533
Río Negro	2	1.58	0.2635
Salta	3	1.61	0.2993
Santa Cruz	2	0.93	0.4351
Tierra del Fuego	2	0.57	0.5881
Country	3	0.53	0.467

Table 21: Panel estimation of effects of ΔZ

Variables	$\Delta TR_{i,t}$	$\Delta Y_{i,t}$
$\Delta Z_{i,t}$	-0.035 (0.029)	-0.877 (1.135)
$\Delta Z_{i,t-1}$	0.017 (0.031)	-0.241 (1.567)
$\Delta Z_{i,t-2}$	-0.160 (0.113)	-1.313 (1.155)
$\Delta Z_{i,t-3}$	-0.03 (0.021)	0.732 (0.947)
Observations	288	288
R^2	0.610	0.346

Robust standard errors in parenthesis.

All regressions include provincial and year fixed effects.

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

Table 22: Estimation of autoregressive equations in first differences for royalties and Coparticipation transfers

	Royalties			Coparticipation transfers		
	(1)	(2)	(3)	(1)	(2)	(3)
Constant	0.029 (0.027)	0.038 (0.029)	0.058* (0.031)	0.032 (0.038)	0.036 (0.035)	0.021 (0.035)
1 lag	0.334* (0.169)	0.133 (0.270)	-0.008 (0.289)	0.188 (0.254)	0.222 (0.234)	0.163 (0.290)
2 lags		0.288 (0.189)	0.032 (0.270)		-0.637* (0.26)	-0.510* (0.262)
3 lags			0.255 (0.207)			-0.208 (0.328)
AIC[a]	-23.784	-21.748	-19.716	-13.167	-15.519	-14.714
B-G[b]	0.3025	0.2372	0.7139	0.512	0.875	0.194
CV[c]	2.171				2.086	

Standard errors in parenthesis.

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

[a] Akaike statistic. [b] Breusch-Godfrey statistic for the highest lag.

[c] Coefficient of variation of the error term.

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