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## Abstract

Based on the fiscal regime that prevailed in Argentina from 1988 to 2003, we estimate the effects that changes in intergovernmental transfers and hydrocarbon royalties had on provincial public consumption and debt. From a one-peso increase in intergovernmental transfers, all provinces spent 76 centavos on public consumption and decreased their debt by 22 centavos. However, when hydrocarbon-producing provinces faced a one-peso increase in royalties, they saved 95 centavos. We provide evidence that the exhaustible nature of royalties may explain this saving reaction in hydrocarbon-producing provinces.


JEL-Codes: C300, H720, H770.

Keywords: tax sharing regime, intergovernmental transfers, non-renewable resources, hydrocarbon royalties, provincial public consumption and debt, Argentina.

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# 1 Introduction

This paper examines one of the most important questions in the local public finance literature: How do subnational governments react to shocks to their revenue streams? Particularly, we evaluate how Argentine provinces adapted some of their fiscal policies in response to revenue changes between 1988 and 2009.

Argentina is an interesting case study for two reasons. First, in terms of expenditure, this country is highly decentralized, so provinces have a lot of latitude in spending. Second, provinces get their revenue from different sources: own taxes, national funding paid out in intergovernmental transfers, and, in some jurisdictions, natural resources royalties.[1]

Since 1988, intergovernmental transfers followed an institutional arrangement under a tax-sharing regime called *Coparticipacion Federal de Impuestos*, regulated by Law 23548. This law 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.

At the same time, revenues originating from hydrocarbon production comprised more than 95 percent of all natural resources royalties in Argentina. But, as only some provinces produced hydrocarbons, they received a very large share of the country's natural resources royalties.

These particular features of Argentine fiscal federalism enable us to answer the initial question from two different empirical angles. First, how do provinces react to shocks to Coparticipation transfers, the *common* source of revenue to all of them? Second, how do hydrocarbon-producing provinces respond to shocks to their *two different* sources of revenue?

For this purpose, we estimate two equations, specifying the provincial reactions in public consumption and debt to contemporaneous and lagged changes in Coparticipation transfers and royalties. To deal with some issues that may invalidate the key assumption that shocks to both sources of revenue are truly exogenous, we proceed as follows. To begin with, we truncate our data set and consider only the period between 1988 and 2003. During these years, Coparticipation transfers represented an average of 94 percent

[1] In fact, because of institutional factors 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 shocks to their other incomes. So, in this paper, we focus on intergovernmental transfers and natural resources royalties as the relevant sources of provincial revenues.

of all intergovernmental transfers in Argentina, and international energy prices mainly determined royalties without any discretionary intervention of the national government. Then, we adopt a Bartik-like instrumental variables approach. First, we instrument Coparticipation transfers by using fixed provincial shares interacted with yearly changes in the common pool *Masa Coparticipable*. In order to assess whether such instrument satisfies the exclusion restriction, we follow Goldsmith-Pinkham et al. (2020) and show that the abovementioned shares were not correlated with some observable, socio-economic provincial characteristics in 1988. Second, we instrument royalties by using an index of provincial hydrocarbons abundance in the pre-estimation period interacted with yearly changes in the international oil price. We provide evidence that shows that, from 1988 to 2003, these changes did not have direct effects on the economy of hydrocarbon-producing provinces, suggesting that the instrument influenced public policies only through royalties.

The main results are the following: When provinces faced a one-peso (AR$) increase in Coparticipation transfers, they raised public consumption by approximately 76 centavos (1 centavo = AR$ 0.01) and reduced debt by 22 centavos. On the other hand, when provinces experienced a one-peso increase in royalties, they decreased their debt by 77 centavos without modifying public consumption. These results are robust to different specifications of the basic regressions.

As the last type of reaction may be driven by the fact that only some provinces earn natural resources royalties, and among them, just eight got almost all these revenues, we next proceed to separate the provinces into two groups: the hydrocarbon-producing provinces and the others. In each group, we run the same two regressions. We confirm that, concerning their responses to shocks to Coparticipation transfers, hydrocarbon-producing provinces behaved like the others, spending nearly 2/3 of any increase in this source of revenue to raise their public consumption. However, when they faced a one-peso increase in royalties, these eight provinces reacted in the exact opposite direction: they cut down their debt by 95 centavos.

We provide two plausible explanations for these sharp differences in fiscal responses. 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, 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. So, according to the literature on the optimal use of revenues from nonrenewable natural resources, hydrocarbon-producing provinces were likely to save most of their royalties.

Finally, we investigate if there is any evidence in the data that points to one of these two explanations as the cause of such behavior. We were not able to detect any effect of the different volatilities of both revenue sources on the fiscal reactions of hydrocarbon-producing provinces. But, on the other hand, we find a significant positive relationship between changes in the depletion index and how much these provinces save when they face increases in royalties.

**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 to cope with the endogeneity problems prevalent in previous estimations, in particular of the so-called flypaper effect.[2] 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[3] only studied the impact of one source of income on fiscal policies, whereas we incorporate a second one. This enables us to assess whether subnational fiscal policies react differently, according to which revenue source has changed.

In addition, we follow the literature that views reactions of fiscal policies to shocks in public revenues at the local level as being guided by intertemporal considerations. Using aggregate data for state and local governments in the United States, Holtz-Eakin and Rosen (1991) and Holtz-Eakin et al. (1994) performed time series estimations to inves-

[2]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. For surveys on this issue, see Gramlich (1977), Hines and Thaler (1995), Bailey and Connolly (1998), Gamkhar and Shah (2007), and Inman (2008).

[3]Other contributions to this literature are Lutz (2010), Lundqvist (2015), Arvate et al. (2015), and Vegh and Vuletin (2015).

tigate whether spending is determined by current or more permanent income sources. Their results were mixed: 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) confirmed such behavior only for 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 income sources: Coparticipation transfers and hydrocarbon royalties. We confirm that, even when fiscal rules were implemented without political discretion from 1988 to 2003, Argentine provincial governments displayed a high consumption sensitivity with respect to Coparticipation transfers. This conclusion is similar to the results found by Sturzenegger and Werneck (2006), Rodden and Wibbels (2010), and Vegh and Vuletin (2015), among others.[4]

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 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 Warmer 1995) and, more recently, using panel data estimation which allows for correcting omitted variables biases (see Aslaksen 2010 and Collier and Goderis 2012).

[4]Still, we have to bear in mind that, although 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 (1988-2003 in place of 1963-2006), and a different empirical model (two equations rather than a single one).

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.[5] As in Martínez (2016), we instrument revenue 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 possible 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 the results. At the subnational level, the closest paper to ours is Cassidy (2018), who 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 effects. Our results also state that Argentine hydrocarbon-producing provinces have behaved -at least during the period under analysis- in a similar way: they spent nearly two-thirds of an increase in Coparticipation transfers in increasing public consumption, while they did not react in the same way when they face a shock to royalties. However, as our model includes debt management, we find that these provinces saved their increases in royalties, moved by a concern about their non-renewable nature. We believe that this finding further contributes to the

[5] For example, Caselli and Michaels (2013) used municipal oil output to instrument for municipal revenue in 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 (2016) exploited time variation in the global oil price, together with cross-sectional variation in oil intensity during a previous period in Colombian municipalities.

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 discuss the identification strategy, particularly the instrumental variables approach that we use. In Section 4, we empirically estimate how fiscal policies react to changes in the different sources of public revenues in all provinces. Section 5 studies these fiscal reactions, but in hydrocarbon-producing provinces. We suggest some plausible explanations for their observed behavior and present evidence regarding the presence of one of the mechanisms in the data. We conclude in section 6. In the Appendix, we present unreported results. All supplementary material appears in an Online Appendix.

## 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).[6,7] Figure 1 is an administrative map of Argentina.[8]

To appreciate Argentina's subnational heterogeneity, Table 1 presents some 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'.[9] 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 very few people (such as Catamarca, La Rioja, and Santa Cruz, all with less than 1 percent of the total population) or low participation in

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

[7]The provinces are divided into 2,171 municipalities. But as the latter play a minor role in local public finances in Argentina, we only focus on fiscal behavior at the provincial level.

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

[9]INDEC (1984) defines a household with 'unmet basic needs' as being 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.

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

| Province | (1) Area ($km^2$) | (2) Population (Hab.) | (3) Density ($Hab/km^2$) | (4) GPP/GDP (%) | (5) GPP p.c. (2004 AR$) | (6) Poverty (%) |
|---|---|---|---|---|---|---|
| Buenos Aires | 307,751 | 13,827,203 | 44.93 | 35.06 | 14,171 | 13.0 |
| 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 | 24.0 |
| 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 | 28.0 |
| 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 | 13.0 |
| 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

Figure 1: Administrative map of Argentina


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 provincial public sector in Argentina

From 1988 to 2003, the size of the provincial public sector (in terms of expenditure) increased, from 29.8 to 36.1 percent of the consolidated public sector. This aggregate figure hides great differences among the provinces, as Table 2 shows.

Table 2: Average size of provincial public sectors (as percent of GPP), 1988-2003

| 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.

In some provinces (like Formosa and Santiago del Estero), the public sector has a significant participation in their corresponding GPP. Comparing this table with Table 1, we note 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

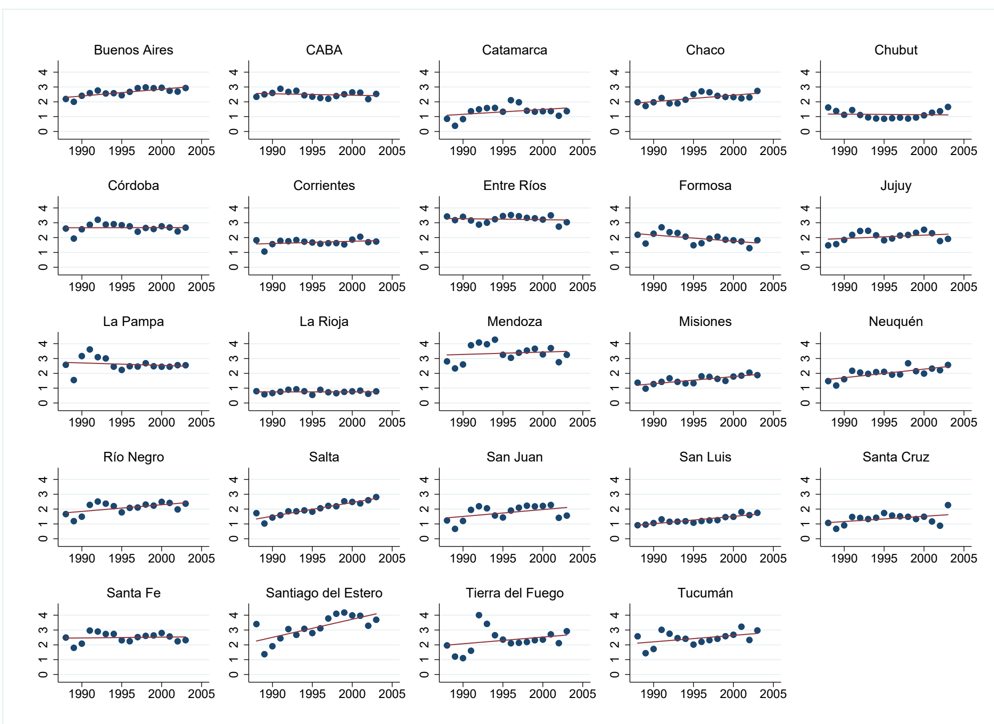
According to the Argentine constitution, the national government has exclusive control over some domains (like defense and foreign affairs), but shares with subnational governments responsibilities and service provision for a broad range of public services (such as economic infrastructure, social insurance, and poverty programs). Primary and secondary education, municipal organization, and local services, on the other hand, are the exclusive realms of the provinces. As a consequence of these institutional features, on average, the national government was in charge of 55 percent of the country's public expenditures, between 1988 and 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). During this period of time, these two components represented, on average, 80 percent of public expenditures at the provincial level (see Table 21 in Appendix 7.9).

## 2.3 Fiscal revenues

**Taxes** For historical reasons, 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 own tax collection over GPP presents no statistically significant slope or, when it is statistically significant, its economic significance is negligible.[10]

Figure 2: Provincial own tax collection (as percent of GPP)




Source: Dirección Nacional de Relaciones Económicas con las Provincias.

What explains these low percentages? First, provincial revenues are concentrated in only a few taxes.[11] Between 1988 and 2003, gross receipts, real state, and vehicle taxes generated, on average, 81 percent of provincial fiscal revenues. In particular, the gross

[10]In Section 4.1.3, we analyze the particular case of Santiago del Estero because it is the province with the most significant increase in tax receipts from 1988 to 2003.

[11]In Section 1 of the the Online Appendix, we describe the historical reasons that explain this fiscal feature at the provincial level.

receipts tax explains 79 percent of these revenues. As this tax is levied at all stages of production and is cumulative, its rates are usually relatively low and can hardly be increased. Di Grescia (2003) applies stochastic frontier techniques and shows that historically 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.

**Royalties** Some provinces also receive royalties from natural resources. In particular, for Chubut, La Pampa, Mendoza, Neuquén, Río Negro, Salta, Santa Cruz, and Tierra del Fuego this source of income represents 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.[12,13]

The regime of hydrocarbon royalties was determined by Law 17319, enacted in 1967, which established a procedure to cash them, procedure that applied to all provinces.[14] Under this regime, the national government set a uniform rate for all provinces of 12 percent[15] of the value of oil and/or gas computable production, evaluated at domestic prices at the production site. Moreover, the Secretary of Energy was charged with auditing whether firms accurately reported their level of production. Royalties were collected by the national government, and then returned to the provincial governments where the oil and/or gas exploitation had originally taken place.[16]

Before 2002, domestic oil and gas prices had been equal to their corresponding international prices because i) no public intervention created a wedge between those prices and, ii) 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 sovereign-debt crisis, when not only was the

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

[13] Formosa and Jujuy also have hydrocarbon resources, but they received very few royalties during the period under analysis.

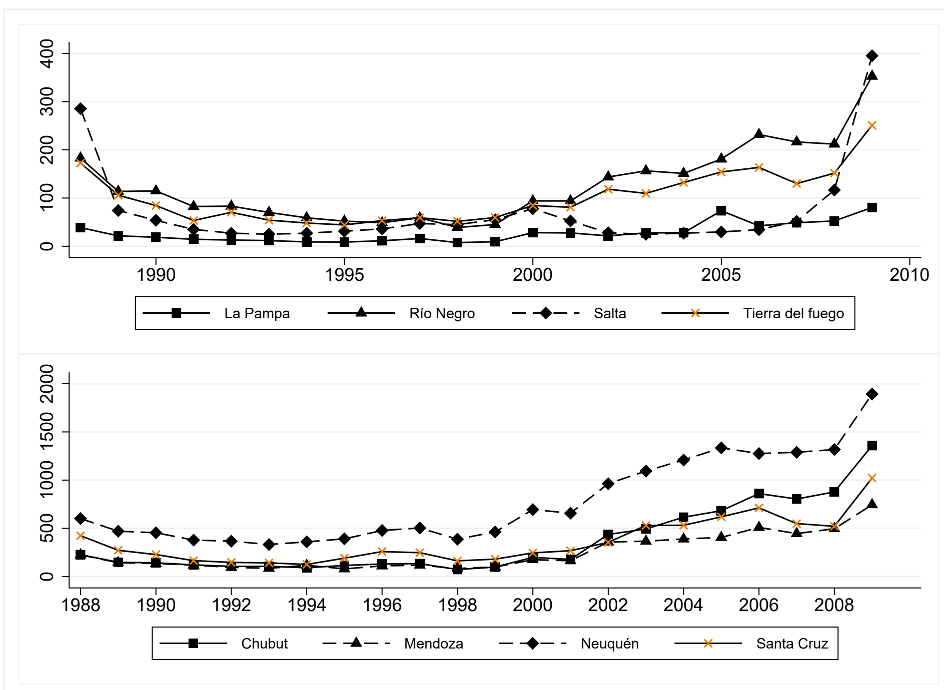
[14] In Section 2 of the Online Appendix, we describe the legal regimes that rule royalties on mineral exploitation and hydroelectricity generation.

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

[16] 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.

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 energy prices on the Argentine economy (see Kawamura, 2017). Therefore, domestic prices and royalties began to disconnect from international prices. Figures 3 and 4 depict the evolution of royalties for hydrocarbon-producing provinces and the international oil price, respectively, between 1988 and 2009.

Figure 3: Hydrocarbon royalties (in millions of 2004 AR$)



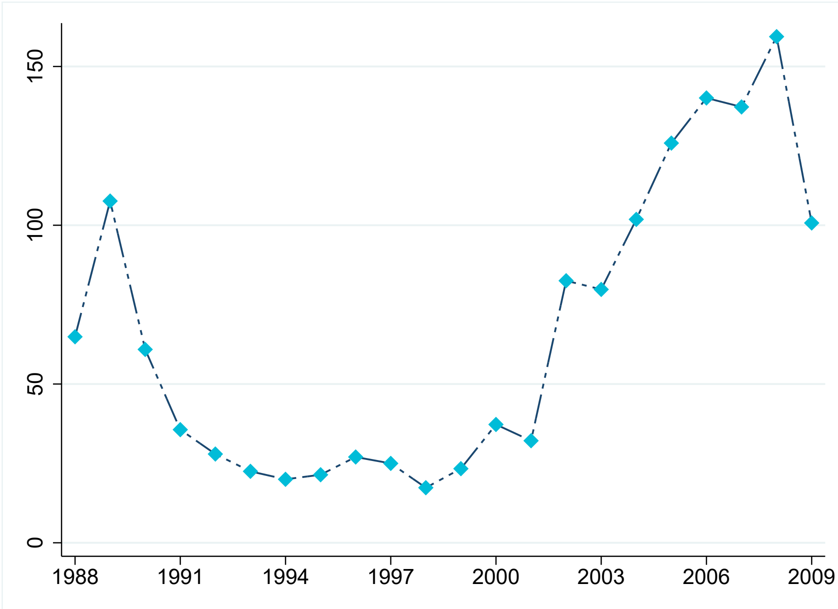

Source: Dirección Nacional de Relaciones Económicas con las Provincias.

Despite the important socioeconomic and geological differences among hydrocarbon-producing provinces, their royalties fluctuated similarly, most of the years following the international oil price.[17] But we can observe that after 2002, as a result of national government regulations, royalties increased relatively less than the international oil price.[18]

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

[18]In fact, after 2003, the correlation between changes in royalties and in the international oil price is negative. See Figure 14 in Appendix 7.9.

Figure 4: International oil price (in 2004 AR$/m$^3$)




Source: Instituto Argentino del Petróleo y del Gas.

## 2.4 Non-fiscal revenues

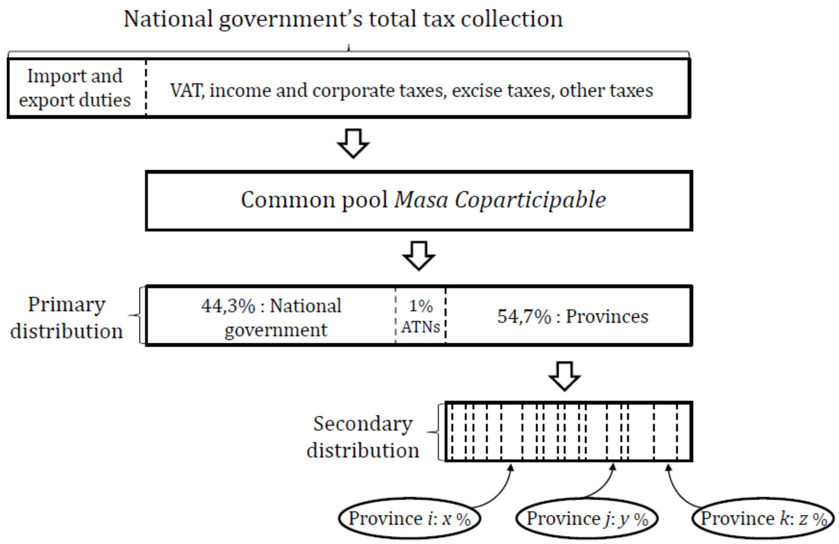
The gap between provincial expenditures and revenues generates an important vertical fiscal imbalance, solved through a system of intergovernmental transfers and the possibility of provincial governments to issue debt.

**Intergovernmental transfers** The system of intergovernmental transfers is based on a tax-sharing regime called *Coparticipación Federal de Impuestos*,[19] regulated by Law 23548 (1988). 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.[20] The peculiarities of this legal framework are explained in detail below, and Figure 5 illustrates the main features of the law.

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

[20]This rule reinforced the persistent difficulty that Argentine provinces have faced to increase their own tax revenues.

Figure 5: Argentina's tax-sharing regime *Coparticipación Federal de Impuestos*




Source: Own making, based on Articles 3 and 4 of Law 23548.

First, Law 23548 stipulates that, with the exception of specific earmarked taxes and import or export duties, taxes collected by the national government form the common pool *Masa Coparticipable*. Then, Article 3 specifies a primary distribution of this common pool, as follows: 44.34 percent corresponds to the national government,[21] 54.66 percent has to be shared among all provinces, and the remaining 1 percent makes up a fund called *Fondo de Aportes del Tesoro Nacional*.[22] The law also establishes the secondary distribution: From the part of the common pool that is assigned to all provinces, each province should receive a **fixed share**, called coefficient. These coefficients are set in Article 4, as follows[23]

Table 3: Legal coefficients of the secondary distribution (in percent)

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

[21]From the national government's part, 2 percent have to be retracted to recover the relative level of intergovernmental transfers received by Buenos Aires (1.5701 percent), Chubut, Neuquén and Santa Cruz (0.1433 percent to each of them)

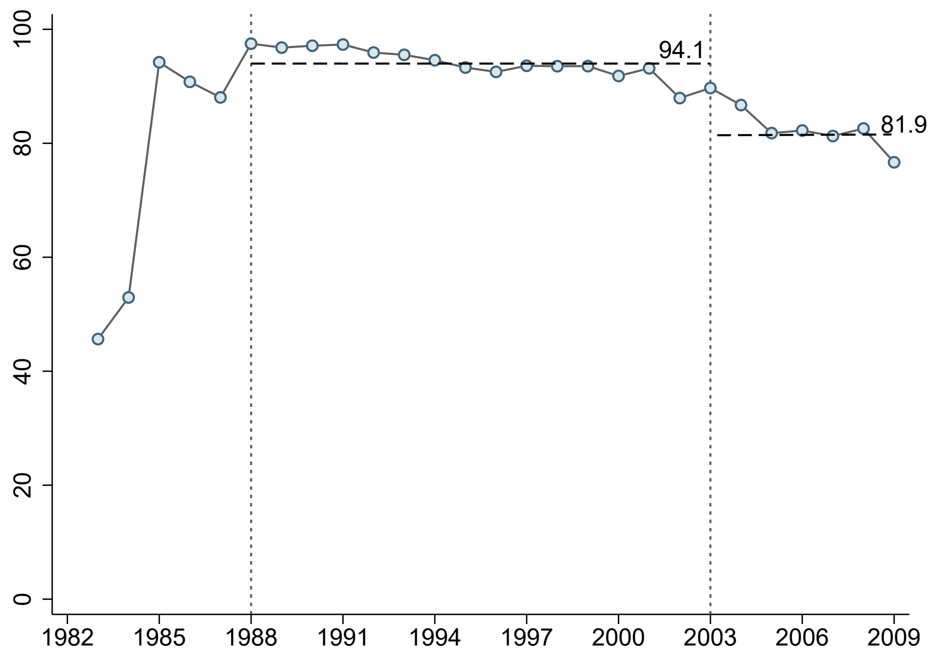
[22]The transfers called *Aportes del Tesoro Nacional* (ATN's) come from this fund, and are distributed discretionally by the Minister of Interior, to help provinces facing unforeseen contingencies.

[23]In Appendix 7.1, we explain how these coefficients were determined by the Congress.

Moreover, Article 6 of Law 23548 dictates that these funds should be automatically transferred to the provinces daily. Also, the national government cannot instruct provinces on how to use these funds that have neither explicit nor implicit matching provisions. Thus, Coparticipation transfers are unconditional, lump-sum grants.

In order to assess their importance, Figure 6 depicts the aggregate amount of Coparticipation transfers received by all provinces, between 1983 and 2009.

Figure 6: Total Coparticipation transfers (as percent of all intergovernmental transfers)




Source: Dirección Nacional de Relaciones Económicas con las Provincias

The figure shows three distinct periods. Before 1988, the percentage changes yearly. As we explain in Appendix 7.1, between 1983 and 1985, Coparticipation transfers were set according to Law 20221 (1973) and, through a secondary distribution formula, they depended in some way on provincial policies. 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 (including the discretionary ones) in Argentina. Indeed, the average share, which is depicted in the figure as a horizontal dotted line, was equal to

94.1 percent.

After 2003, this share started to decline. From 2004 to 2009, the average was 81.9 percent. Although Law 23548 continued to rule the tax sharing regime in Argentina, 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 government.[24] 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 and have not followed the pattern of their assignment in previous years (see Appendix 7.2).

Figure 7 plots the time series of Coparticipation transfers between 1988 and 2009. We observe a fairly common pattern of evolution of these transfers across time, consistent with the fact that they depended, in great part, upon shocks to the national economy.

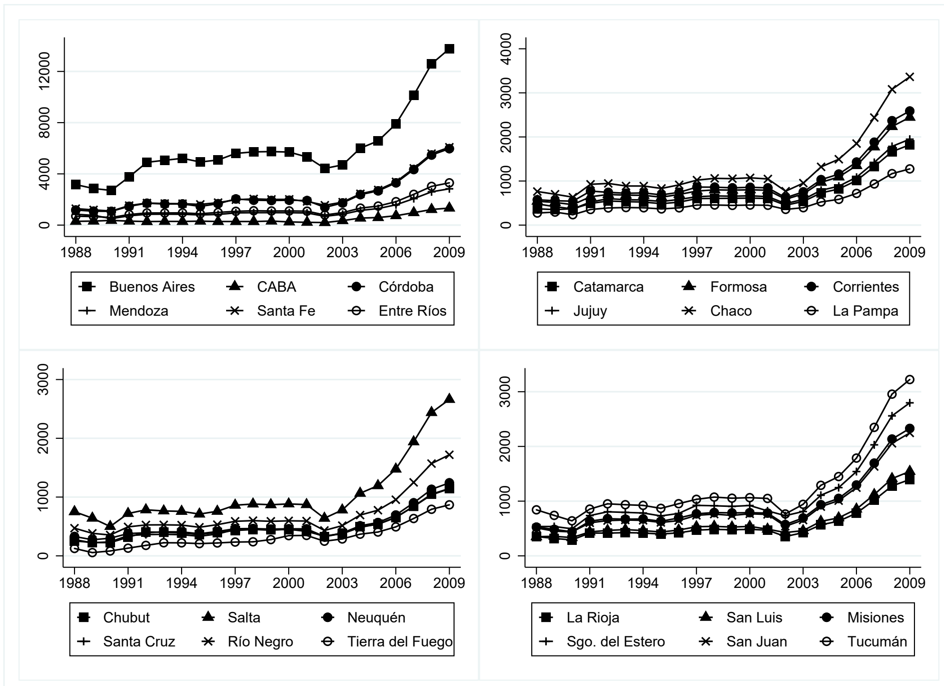
**Debt** The other instrument that helps to close the vertical fiscal gap is domestic and foreign debt issuance by provincial governments. During the period under analysis, provincial authorities borrowed domestically, mainly from commercial banks (either private or public) and the national government.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

Although some provinces enacted regulations to restrict debt issuance, in Section 3 of the Online Appendix we show that these regulations were seldom binding. Therefore, provinces had a lot of latitude to deal with budgetary difficulties using debt, which is exactly what they did. 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 4 shows the average provincial per capita stock of debt for this period, with its corresponding coefficient of variation.

The contrast between these figures is important: The average provincial per capita stock of debt 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. In particular, the coefficient of variation of some hydrocarbon-producing provinces are among the highest ones.

[24] During the 2001-2002 macroeconomic crisis, the national government introduced taxes on exports and financial transactions. These revenues were not incorporated into the common pool Masa Coparticipable and thus were not automatically transferred to the provinces. Using emergency powers that the Congress delegated 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.

Figure 7: Coparticipation transfers, by province (in millions of 2004 AR$)




Source: Dirección Nacional de Relaciones Económicas con las Provincias

Table 4: Provincial per capita stock of debt (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 | 888.00 | 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 | 2.10 | Santiago del Estero | 296.96 | 0.78 |
| La Pampa | 260.75 | 1.73 | Tierra del Fuego | 241.82 | 9.47 |
| La Rioja | 1,578.60 | 0.57 | Tucumán | 664.72 | 0.60 |

Source: Dirección Nacional de Relaciones Económicas con las Provincias.

# 3 Empirical analysis

In this section, we start the empirical investigation of the way provincial fiscal policies react to changes in different sources of income. We discuss the identification strategy, focusing on the instrumental variable approach adopted. Then we describe the data employed.

## 3.1 Identification strategy

As in Holtz-Eakin et al. (1994) and Dahlberg and Lindström (1998), we suppose that provincial governments optimally choose their fiscal policy intertemporally, taking into account 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 view both sources of income as random variables, determined out of their control. Provincial governments also tax their residents and can issue debt freely.

We consider the following equations

$$G_{it} = \psi^G.t + \sum_{s=0}^{k} \alpha_s^G TR_{it-s} + \sum_{s=0}^{k} \beta_s^G R_{it-s} + \sum_{s=0}^{k} \gamma_s^G Y_{it-s} + \delta_i + \lambda_t + \nu_{it}, \quad (1)$$

$$D_{it} = \psi^D.t + \sum_{s=0}^{k} \alpha_s^D TR_{it-s} + \sum_{s=0}^{k} \beta_s^D R_{it-s} + \sum_{s=0}^{k} \gamma_s^D Y_{it-s} + \delta_i + \lambda_t + \mu_{it}, \quad (2)$$

where $i$ represents a province and $t$, a year. Public expenditures and debt are denoted by $G_{it}$ and $D_{it}$, respectively. As shown in Section 4 of the Online Appendix, both variables exhibit a linear trend. Explanatory variables include contemporaneous and $s$-period lagged values of Coparticipation transfers $TR_{it}$ and royalties $R_{it}$.[25] As provinces have almost no leeway to improve their own tax collection, we take them as a fixed, small fraction of private sector output. Due to lack of availability of accurate data at the subnational level for these years, we use provincial GPP, $Y_{it}$, to control for this source of income.

[25] As we have assumed that provincial authorities optimize intertemporally, we incorporate lagged values of all independent variables to confirm if shocks to the sources of income in $t-s$ affect contemporaneous and future levels of expenditures and debt. Besfamille et al. (2017) present a simple model to justify the inclusion of such lagged values.

Besides the abovementioned explanatory variables, we include provincial fixed effects $(\delta_i)$ and time dummies $(\lambda_t)$. Finally, $\nu_{it}$ and $\mu_{it}$ are error terms.

As all variables may be integrated of order one, we take first differences of equations (1) and (2) to avoid spurious regression results:

$$\Delta G_{it} = \psi^G + \sum_{s=0}^{k} \alpha_s^G \Delta TR_{it-s} + \sum_{s=0}^{k} \beta_s^G \Delta R_{it-s} + \sum_{s=0}^{k} \gamma_s^G \Delta Y_{it-s} + \epsilon_{it}, \tag{3}$$

$$\Delta D_{it} = \psi^D + \sum_{s=0}^{k} \alpha_s^D \Delta TR_{it-s} + \sum_{s=0}^{k} \beta_s^D \Delta R_{it-s} + \sum_{s=0}^{k} \gamma_s^D \Delta Y_{it-s} + \rho_{it}, \tag{4}$$

where $\epsilon_{it} = \Delta\lambda_t + \nu_{it}$ and $\rho_{it} = \Delta\lambda_t + \mu_{it}$. We estimate (3) and (4) separately, using OLS. Moreover, standard errors are clustered at the provincial level, to address potential issues of serial correlation (see Bertrand et al. 2004). Particularly, as the number of clusters (24) is relatively small, we follow Cameron and Miller (2015) and use a bootstrap procedure to obtain clustered-robust standard errors.

The estimation of equations (3) and (4) raises matters of some concern. Regarding Coparticipation transfers, the following issues may worry us. First, Casás (1996) and Galiani et al. (2016) document that, since 1990, various reforms created new transfers within the Coparticipation regime, which altered its initial simple design depicted in Figure 5.[26] Second, since 1992, Buenos Aires has received additional revenues from of a special fund called *Fondo de Financiamiento de Programas Sociales en el Conurbano Bonaerense*. The resources to form this fund came from the common pool *Masa Coparticipable*, before its primary distribution. These supplementary transfers, which reached AR$650 million in some years, have been held constant (in nominal terms) since 1995. All these legal changes to the Coparticipation regime followed political negotiations between the national government and provincial authorities that took place after Law 23548 was enacted, thus potentially invalidating the assumption that the new transfers were truly exogenous to provincial spending and debt management. Hence, as the official data on Coparticipation transfers aggregate those initially defined by Law 23548 and the new ones, the variable $TR_{it}$ can be endogenous.

[26] For example, Law 24699 determined that AR$440 million should be annually deducted from the common pool *Masa Coparticipable* to endow the fund *Fondo Compensador de Desequilibrios Provinciales*, whose goal was to compensate for financial disequilibria between provinces. These resources should be distributed to the provinces, according to the legal coefficients presented in Table 3.

To address these concerns, we look at instrumenting Coparticipation transfers. Although this may seem challenging a priori, one particular aspect of the fiscal relations in Argentina can help find a valid instrument: Almost all intergovernmental transfers created since 1990 were also distributed according to constant and fixed coefficients, similar to those defined in Law 23548. We thus suggest to use the following Bartik-type instrument for changes in Coparticipation transfers,

$$W_{it} \equiv \theta_i . \Delta MC_t,$$

where $\theta_i$ is the share of province $i$ and $\Delta MC_t$ is the contemporary change in the common pool *Masa Coparticipable* at year $t$. The shares satisfy $\sum_i \theta_i = 1$ and were computed using only the legal secondary distribution coefficients defined in Law 23548.[27]

The legal secondary distribution coefficients defined by Law 23548 were not modified by the national government nor negotiated between regional representatives in Congress on a yearly basis; in fact, they have been legally fixed since 1988.[28,29] Hence, the shares $\theta_i$ were also fixed between 1988 and 2003, and so no political channel like those analyzed by Knight (2002) or Johansson (2003) can create an endogeneity problem here. Moreover, as the legal coefficients were not defined by a formula, they do not depend upon observable (geographic, demographic or socioeconomic) characteristics, expenditures or any other outcome of provincial policies. This excludes the possibility of reverse causation: provincial governments cannot set their policies' outcomes or manipulate socioeconomic indicators in order to obtain more resources from the national government. By construction, the shares $\theta_i$ inherit these properties.

In order to justify the exclusion restriction of our instrument $W_{it}$, we follow Goldsmith-Pinkham et al. (2020) and examine how much the shares $\theta_i$ that account for much of the key variation are correlated with other potential confounders in 1988. In Appendix 7.3,

[27] In Section 5 of the Online Appendix, we explain how we obtain the shares $\theta_i$.

[28] The main reason that explains this institutional feature of the Argentine tax-sharing regime is that 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 absolute majority of each congressional house, and then iii) has to be approved by all provincial legislatures. Therefore, it is not surprising that, although the 1994 constitutional amendment mandated the Congress to approve a new Coparticipation law by 1996, this has still not happened.

[29] Vegh and Vuletin (2015) also analyze the response of provincial expenditures to federal transfers in Argentina, but from 1963 to 2006. During this extended period of time, there were several changes to the intergovernmental transfers regime, and in particular in their secondary distribution [see Porto 2004], where negotiations in Congress played a key role. This justifies why these authors use changes in the index of provincial representation in Congress as an instrument for federal transfers.

we present evidence confirming that the shares $\theta_i$ were not correlated with observable provincial characteristics evaluated near 1988, except with population.[30]

The second component of our instrument, the contemporary change in the common pool $\Delta MC_t$, is completely determined by shifts in the national tax collection, out of the direct control of the provinces. 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 particular province represents an important fraction of the national GDP. These shocks could have independent and direct effects on public spending in this particular province, which would induce a bias in the estimation. In Section 4.1.2, we deal with this potential source of endogeneity.

We thus consider $W_{i,t}$ as a valid instrument for Coparticipation transfers, implying that their conditional variation is driven by changes in the national tax collection.

Some issues regarding royalties may also invalidate our identification strategy. First, we know that, in our data set, this variable is subject to measurement errors: Even for hydrocarbon-producing provinces, royalties include those coming from mineral resources and hydroelectricity generation.[31] And, as we explain in Section 2 of the Online Appendix, the amount of such royalties clearly depend on decisions adopted by provincial authorities. 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.[32] 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

[30] We address the potential endogeneity issue concerning population in Section 4.1.2.

[31] Unfortunately, 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.

[32] For example, the provision of some public goods could affect firms' decisions to initiate the exploitation of a given site or their production processes.

increase social programs to appease such a political situation).[33] This could generate a spurious correlation among these variables, biasing the estimation results.

To address these concerns, we run the regressions using the following Bartik-type instrument for changes in provincial royalties,

$$Z_{it} \equiv q^{o}_{i1987}.\Delta p^{*}_{t},$$

where $q^{o}_{i1987}$ is province $i$'s oil production in 1987 and $\Delta p^{*}_{t}$ is the contemporaneous change in the international oil price.

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

The use of $\Delta p^{*}_{t}$ as the second component of $Z_{it}$ 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). Finally, in principle, the international oil price can have a different impact on the economies of hydrocarbon-producing provinces than on those of jurisdictions less dependent on hydrocarbons extraction. If this were the case, it would invalidate the exclusion restriction that the instrument affects the dependent variables only via royalties. In Appendix 7.4, we investigate if our instrument was correlated with changes, at the provincial level, in GPP and unemployment, for all provinces, and for the eight hydrocarbon-producing ones. We find non-significant results. Moreover, in Appendix 7.7, we follow Angrist et al. (2010) and present supplementary evidence that supports the exclusion restriction, by estimating reduced form effects of our instrument in a sub sample of provinces with low first stage. Summing up, we believe that $Z_{it}$ can be considered a valid instrument for royalties, implying that their conditional variation is driven by changes in the international oil price.

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

## 3.2 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.

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. All 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.[34]

Data on Coparticipation transfers and royalties also comes from this department.

We build a time series of the common pool *Masa Coparticipable*, by substracting import and export duties from to the national tax collection. These figures are obtained from Dirección Nacional de Investigaciones y Análisis Fiscal, another department of the Ministry of Economy.

Oil and gas production and reserves were obtained from *Anuario de Combustibles*, a yearly publication from the (former) Dirección Nacional de Energía y Combustibles.[35] 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.

We use data on provincial unemployment from Observatorio de Empleo y Dinámica Industrial, at the Ministry of Labor, Employment and Social Security. Finally, provincial GPP is obtained from Porto (2004) for the period 1987-2000 and from the Ministry of Economy for the period 2001-2009.

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 5.

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

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

Table 5: Summary statistics

| Variable | Mean | Std. Dev. | Max. | Min. | Obs. |
|---|---|---|---|---|---|
| $\Delta G_{it}$ | -0.001 | 0.23 | 1.571 | -1.164 | 360 |
| $\Delta D_{it}$ | 0.139 | 0.285 | 1.46 | -0.602 | 360 |
| $\Delta TR_{it}$ | -0.001 | 0.179 | 0.636 | -1.358 | 360 |
| $\Delta TR_{it-1}$ | -0.01 | 0.181 | 0.636 | -1.358 | 336 |
| $\Delta TR_{it-2}$ | 0.012 | 0.159 | 0.636 | -1.358 | 312 |
| $\Delta R_{it}$ | -0.006 | 0.143 | 0.821 | -1.36 | 360 |
| $\Delta R_{it-1}$ | -0.009 | 0.14 | 0.585 | -1.36 | 336 |
| $\Delta R_{it-2}$ | -0.017 | 0.134 | 0.479 | -1.36 | 312 |
| $\Delta Y_{it}$ | 0.088 | 1.687 | 8.688 | -13.107 | 360 |
| $\Delta Y_{it-1}$ | 0.029 | 1.72 | 8.688 | -13.107 | 336 |
| $\Delta Y_{it-2}$ | 0.086 | 1.759 | 8.688 | -13.107 | 312 |
| $q_{i1987}$ (in thousands $m^3$) | 1,036.131 | 1,854.521 | 5,855.261 | 0 | 24 |
| $p_t$ (in 2004 AR$ per $m^3$) | 49.34 | 31.68 | 123.82 | 18.35 | 16 |

# 4 Fiscal reactions in all provinces

In this section, we present the results regarding the fiscal reactions in all provinces, and then analyze some robustness checks. Table 6 provides the first series of estimations of the paper, where we display three different specifications of equations (3) and (4), each one including contemporaneous, one and two-period lagged changes of all regressors.

In panel (A), we use the entire data set, without instrumenting provincial revenues. The results show a significant, economically important, positive reaction of public expenditures to the contemporaneous change in Coparticipation transfers, and significant (but economically less important) positive reactions 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 dimension because endogeneity issues are prevalent. In particular, as we have already mentioned, since 2003, discretionary transfers from the national government started to become a relevant source of income for many provinces. Therefore, after this date, when a provincial government faced a positive shock to Coparticipation transfers, it may have reacted by spending above it, anticipating that, in case of a posterior reversal in this source of income, it could be compensated or even rescued via discretionary transfers.

Provincial reactions to changes in royalties are different. Facing a contemporaneous and a one-period lagged increase in this source of revenue, provinces do not modify their public expenditures; instead they decrease debt in a statistically and economically significant way. Again, these results cannot be considered as proofs of a causal relation because

Table 6: Fiscal responses, all provinces

| | (A) | | (B) | | (C) | |
|---|---|---|---|---|---|---|
| | $\Delta G_{it}$ | $\Delta D_{it}$ | $\Delta G_{it}$ | $\Delta D_{it}$ | $\Delta G_{it}$ | $\Delta D_{it}$ |
| $\Delta TR_{it}$ | 1.039*** | -0.155 | 0.592*** | -0.168 | 0.760*** | -0.216* |
| | (0.121) | (0.108) | (0.142) | (0.130) | (0.074) | (0.125) |
| $\Delta TR_{it-1}$ | 0.360*** | 0.057 | 0.204*** | 0.077 | 0.209*** | 0.059 |
| | (0.064) | (0.128) | (0.063) | (0.052) | (0.070) | (0.088) |
| $\Delta TR_{it-2}$ | 0.256** | 0.137** | 0.048 | 0.015 | 0.092 | 0.007 |
| | (0.107) | (0.064) | (0.172) | (0.151) | (0.157) | (0.157) |
| $\Delta R_{it}$ | 0.064 | -0.344** | -0.295 | -0.610* | -0.231 | -0.764** |
| | (0.083) | (0.172) | (0.366) | (0.341) | (0.261) | (0.343) |
| $\Delta R_{it-1}$ | -0.029 | -0.436** | 0.187 | -0.084 | 0.147 | -0.055 |
| | (0.142) | (0.208) | (0.152) | (0.255) | (0.173) | (0.300) |
| $\Delta R_{it-2}$ | 0.110 | -0.432 | -0.373** | -0.582** | -0.305 | -0.575* |
| | (0.187) | (0.329) | (0.166) | (0.259) | (0.198) | (0.331) |
| $\Delta Y_{it}$ | 0.014 | -0.022** | 0.003 | -0.021 | 0.002 | -0.022 |
| | (0.019) | (0.011) | (0.010) | (0.016) | (0.011) | (0.017) |
| $\Delta Y_{it-1}$ | 0.012 | 0.007 | 0.027* | 0.018* | 0.026 | 0.019* |
| | (0.011) | (0.013) | (0.016) | (0.010) | (0.016) | (0.011) |
| $\Delta Y_{it-2}$ | -0.002 | 0.015 | -0.017 | 0.009 | -0.015 | 0.008 |
| | (0.012) | (0.009) | (0.013) | (0.010) | (0.013) | (0.010) |
| Constant | -0.001 | 0.085*** | 0.001 | 0.116*** | -0.001 | 0.118*** |
| | (0.008) | (0.019) | (0.006) | (0.023) | (0.007) | (0.024) |
| Anderson-Rubin test | | | | | 104.19*** | 7.43** |
| Number of clusters | 24 | 24 | 24 | 24 | 24 | 24 |
| Observations | 456 | 456 | 312 | 312 | 312 | 312 |
| $R^2$ | 0.570 | 0.175 | 0.438 | 0.188 | 0.427 | 0.185 |

Bootstrap clustered standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

of potential concerns of endogeneity. As we have already mentioned, since 2003, royalties stopped following the evolution of international energy prices; 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 represented on average 94.1 percent of all intergovernmental transfers (including the discretionary ones) and royalties were computed according to international energy prices. In panel (B), we do not instrument provincial revenues. We observe that the most important statistically significant estimates are economically different from the previous specification. The increase in public expenditures in reaction to a contemporaneous change in Coparticipation transfers falls by almost 40 percent while the debt reduction after a contemporaneous change in royalties increases by 77 percent. Clearly, when we restrict the data set to the years when the national policies were less discretionary, provincial authorities behave more conservatively. Last, we also observe a negative and significant reaction of public expenditures to two-period lagged increase in royalties, which is not easy to interpret.

Finally, panel (C) presents the coefficients derived from our preferred specification, when we instrument Coparticipation transfers and royalties, and we estimate equations (3) and (4) with 2SLS.[36,37]

Table 7 presents the first stage for $\Delta TR_{it}$ and $\Delta R_{it}$. In addition to the instruments $W_{it}$ and $Z_{it}$, we add as explanatory variables the lagged changes $\Delta TR_{it-s}$ and $\Delta R_{it-s}$, for $s \geq 1$, and the other regressors that are included in the second stage. For each source of revenue, the estimated coefficient of its corresponding instrument is positive (as predicted) and statistically significant. Moreover, we do not observe significant correlations between $Z_{it}$ and $\Delta TR_{it}$ (or between $W_{it}$ and $\Delta R_{it}$), implying that the instruments affect only their corresponding endogenous variable. As standard errors are clustered, we are in a non-homoskedastic case, where the usual $F$ tests for weak instruments do not apply (see Montiel Olea and Pflueger (2013)). Altough there is, to the best of our knowledge, no test for weak instruments in the non-homoskedastic case with multiple endogenous regressors, Andrews et al. (2019) suggest to use, in just-identified models like this one, the Kleimbergen-Paap Wald statistic. Its $p-$value (0.108) seems to point out a problem of (marginally) weak instruments. Nevertheless, the results of the Anderson-Rubin test reported in Table 6 validate the inference carried out with our instruments.

In the second-stage regression in panel (C), we obtain a positive, statistically and economically significant estimated response of public expenditures, and a negative, but less economically and statistically significant estimated response of debt to the contemporaneous change in Coparticipation transfers. On average, and other things being equal, for each peso of increase in Coparticipation transfers, provincial governments increase current public expenditures by nearly 76 centavos and decrease debt by 22 centavos. These results suggest a low degree of expenditure smoothing to shocks in this source of provincial income. Although this finding stands in sharp contrast to the result obtained by Dahlberg and Lindström (1998), our estimated coefficients are similar to those found by

[36] As changes in public expenditures and debt are simultaneously chosen by provincial governments, the error terms $\epsilon_{it}$ and $\rho_{it}$ may be correlated. But in this case there is no need to estimate (3) and (4) as a system, using a 3SLS method, because these equations have exactly the same regressors.

[37] In Appendix 7.5, we undertake these estimations under different dynamic specifications. Then, in Appendix 7.6, we review our preferred specification, controlling for time fixed effects.

Table 7: First stage

| | $\Delta R_{it}$ | $\Delta TR_{it}$ |
|---|---|---|
| $\Delta TR_{it-1}$ | -0.086 | 0.070 |
| | (0.059) | (0.090) |
| $\Delta TR_{it-2}$ | 0.032 | 0.068 |
| | (0.037) | (0.052) |
| $\Delta R_{it-1}$ | 0.216 | 0.129 |
| | (0.167) | (0.109) |
| $\Delta R_{it-2}$ | 0.010 | -0.207** |
| | (0.149) | (0.094) |
| $\Delta Y_{it}$ | -0.005 | -0.010** |
| | (0.011) | (0.004) |
| $\Delta Y_{it-1}$ | 0.009 | -0.011 |
| | (0.007) | (0.008) |
| $\Delta Y_{it-2}$ | -0.004 | 0.007 |
| | (0.004) | (0.005) |
| $Z_{it}$ | 0.002*** | -0.00018 |
| | (0.001) | (0.000185) |
| $W_{it}$ | 0.030 | 0.790*** |
| | (0.026) | (0.034) |
| Constant | 0.005* | -0.017*** |
| | (0.003) | (0.002) |
| Kleibergen-Paap Wald statistic | 6.654 | |
| Number of clusters | 24 | 24 |
| Observations | 312 | 312 |
| $R^2$ | 0.431 | 0.779 |

Bootstrap clustered standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Holtz-Eakin et al. (1994), but lower than those reported by Vegh and Vuletin (2015).

Regarding the reactions to changes in royalties, we obtain no statistically significant coefficient for public expenditures. But, on the other hand, public debt reacts significantly and negatively, decreasing 77 centavos per peso of increase in this source of revenue. Facing a contemporaneous positive shock to royalties, provincial governments mainly reduce their deficit.

Shocks to both sources of revenue have persistent impacts on provincial policies. Public expenditures increase in reaction to a one-period lagged rise in Coparticipation transfers; while debt decreases facing a two-period lagged increase in royalties. Figure 8 illustrates the cumulative effects of a one peso increase in Coparticipation transfers and royalties, with their corresponding 95% confidence interval.

In panel I, the estimated coefficients imply that three years after receiving one additional peso of Coparticipation transfers, provinces spent 1.061 pesos in public spending. On the other hand, panel II shows that three years after getting one extra peso in royalties, provinces saved 1.394 pesos. Although these values may seem large, we reject the null hypothesis that the accumulated effects are higher than one in both cases. These results suggest that shocks to royalties are more smoothed than those to Coparticipation transfers, contemporaneously and in the medium term.

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) are statistically or economically non significant. 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.[38]

## 4.1 Robustness checks

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

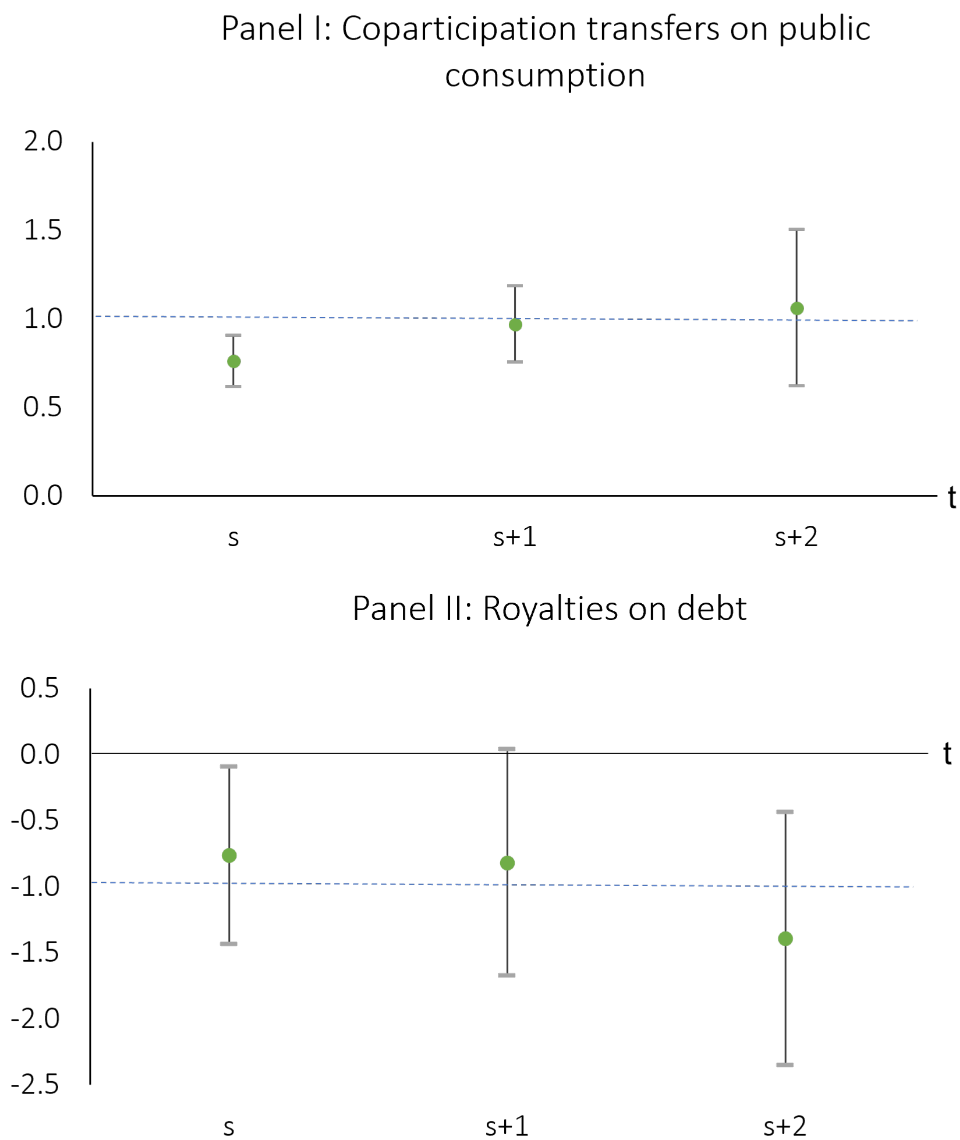
### 4.1.1 Different estimation methods

Table 8 presents the results of our preferred specification when we use other estimation methods.

The inclusion of provincial GPP as a control variable may raise the following concern:

[38]Given these institutional weaknesses, it is difficult to interpret the great difference between the estimated coefficient for changes in provincial private income and the corresponding changes in Coparticipation transfers as evidence of a flypaper effect at the provincial level in Argentina.

Figure 8: Cumulative effects of 1 AR$ increase in both sources of provincial revenue




We cannot exclude a case of reverse causation, with public consumption affecting GPP. To deal with this potential case of endogeneity of our controls, in panel (D) we estimate (3) and (4) eliminating them. The estimated coefficients are very similar to those obtained in panel (C) in Table 6. Therefore, we conclude that incorporating GPP as a control does not modify our results in a significant way.

Under the 2SLS estimation, we assumed that errors were normally distributed, which may be restrictive in this setting. To address this issue, we estimate (3) and (4) using GMM. The results presented in panel (E) are almost identical to those that appear in panel

(C) in Table 6.

Table 8: Robustness checks I: Different estimation methods

| | (D) | | (E) | | (F) | |
|---|---|---|---|---|---|---|
| | $\Delta G_{it}$ | $\Delta D_{it}$ | $\Delta G_{it}$ | $\Delta D_{it}$ | $\Delta G_{it}$ | $\Delta D_{it}$ |
| $\Delta TR_{it}$ | 0.867*** | -0.250** | 0.76*** | -0.216* | 0.764** | -0.214 |
| | (0.055) | (0.103) | (0.071) | (0.124) | (0.085) | (0.134) |
| $\Delta TR_{it-1}$ | 0.218*** | 0.031 | 0.209*** | 0.059 | 0.221*** | 0.064 |
| | 0.077 | (0.104) | (0.074) | (0.091) | (0.07) | (0.091) |
| $\Delta TR_{it-2}$ | 0.163 | 0.067 | 0.092 | 0.007 | 0.089 | 0.006 |
| | (0.145) | (0.158) | (0.159) | (0.154) | (0.163) | ( 0.163) |
| $\Delta R_{it}$ | -0.314 | -0.890** | -0.231 | -0.764** | -0.132 | -0.72* |
| | (0.312) | (0.368) | (0.270) | (0.344) | (0.226) | (0.384) |
| $\Delta R_{it-1}$ | 0.085 | -0.089 | 0.147 | -0.055 | 0.133 | -0.061 |
| | (0.312) | (0.388) | (0.181) | (0.289) | (0.168) | (0.326) |
| $\Delta R_{it-2}$ | (-0.192) | (-0.477) | -0.305 | -0.575** | -0.322 | -0.583* |
| | (0.167) | (0.324) | (0.193) | (0.293) | (0.215) | (0.318) |
| $\Delta Y_{it}$ | | | 0.002 | -0.022 | 0.002 | -0.021 |
| | | | (0.010) | (0.017) | (0.011) | (0.017) |
| $\Delta Y_{it-1}$ | | | 0.026* | 0.019* | 0.026 | 0.019* |
| | | | (0.016) | (0.011) | (0.016) | (0.011) |
| $\Delta Y_{it-2}$ | | | -0.015 | 0.008 | -0.015 | 0.009 |
| | | | (0.013) | (0.01) | (0.013) | (0.01) |
| Constant | 0.001 | 0.119*** | -0.001 | 0.118*** | -0.003 | 0.118*** |
| | (0.006) | (0.024) | (0.007) | (0.023) | (0.007) | (0.024) |
| Anderson-Rubin test | 129.51*** | 4.12** | 104.19*** | 7.43** | 66.12*** | 2.57* |
| Number of clusters | 24 | 24 | 24 | 24 | 24 | 24 |
| Observations | 312 | 312 | 312 | 312 | 312 | 312 |
| $R^2$ | 0.372 | 0.015 | | | 0.488 | 0.194 |

Bootstrap clustered standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

As we have shown that our instruments may be marginally weak, we estimate our preferred specification using heteroskedasticity-based instrumental variables, as proposed by Lewbel (2012). Although the first stage improves, in the sense that the value of the Kleimbergen-Paap Wald statistic slightly increases to 7.32 and becomes marginally significant, the inference of the second stage weakens. Despite this fact, panel (F) shows that the main results presented in panel (C) in Table 6 hold with these new instruments.

### 4.1.2 Groups of similar provinces

In the Appendix 7.3 we established that there is no correlation between the shares $\theta_i$ and socioeconomic provincial characteristics near 1988, except population. It might be the case that this last characteristic and others could affect not only the level of Coparticipation transfers but also spending and debt decisions, which would invalidate our identification strategy. To deal with this potential violation of the exclusion restriction of the instrument $W_{it}$, we estimate the model grouping provinces with similar features that were not explicitly controlled for in previous regressions. Specifically, we define $\Omega_n$ as the set of provinces that share the characteristic $n$, and we add the interaction effect of the dummy

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

with all regressors. In Table 9, each estimation is identified by its corresponding set $\Omega_n$.

**Big provinces** Extremely large macroeconomics shocks that took place during the period under analysis (hyperinflation in 1989, sovereign debt crisis in 2001-2002) may have had differential effects across provinces. Consider the important contractions in provincial public spending that followed these crises. The identifying assumption is that these drops were only caused by the plunge in Coparticipation transfers, after a decrease in the national tax collection. But perhaps they could also be explained by other factors. For example, suppose that big provinces had easier access to the international credit market than small provinces. Thus, after these crisis, the former could not get credit any more, forcing them to decrease expenditures even further.

To see if this channel does represent a threat to our identification strategy, we consider the set $\Omega_1 = \{$Buenos Aires, CABA, Córdoba, Santa Fe$\}$, constituted by the largest four provinces in terms of their share in the national GDP.

All coefficients of the interaction terms between the dummy and changes in Coparticipation transfers are statistically non significant, implying that the reactions to these changes are not different between the four biggest provinces and the others. Hence, we do not see heterogeneous effects of these crises among these two groups of provinces.

We only observe 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,

Table 9: Robustness checks II: Incorporating interactions with dummies characterizing groups of similar provinces

| | $\Omega_1$ | | $\Omega_2$ | | $\Omega_3$ | | $\Omega_4$ | | $\Omega_5$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $\Delta G_{it}$ | $\Delta D_{it}$ | $\Delta G_{it}$ | $\Delta D_{it}$ | $\Delta G_{it}$ | $\Delta D_{it}$ | $\Delta G_{it}$ | $\Delta D_{it}$ | $\Delta G_{it}$ | $\Delta D_{it}$ |
| $\Delta TR_{it}$ | 0.609*** | -0.231** | 0.620*** | -0.251** | 0.602*** | -0.223** | 0.606*** | -0.228** | 0.620*** | -0.275** |
| | (0.102) | (0.094) | (0.124) | (0.105) | (0.105) | (0.096) | (0.104) | (0.095) | (0.130) | (0.110) |
| $\mathbb{1}_i * \Delta TR_{it}$ | 0.633 | -0.500 | 0.050 | 0.255 | 0.343 | -0.300 | 0.338 | -0.289 | 0.038 | 0.116 |
| | (0.847) | (0.872) | (0.343) | (0.283) | (0.212) | (0.289) | (0.314) | (0.343) | (0.144) | (0.192) |
| $\Delta TR_{it-1}$ | 0.191*** | 0.051 | 0.177* | 0.017 | 0.180** | 0.032 | 0.185** | 0.045 | 0.167* | -0.011 |
| | (0.073) | (0.113) | (0.093) | (0.149) | (0.078) | (0.130) | (0.075) | (0.118) | (0.094) | (0.159) |
| $\mathbb{1}_i * \Delta TR_{it-1}$ | 0.093 | 0.107 | 0.045 | -0.032 | 0.192* | 0.149 | 0.178 | 0.113 | 0.113 | 0.242 |
| | (1.384) | (1.094) | (0.297) | (0.371) | (0.115) | (0.197) | (0.299) | (0.275) | (0.149) | (0.192) |
| $\Delta TR_{it-2}$ | 0.208* | 0.156 | 0.205 | 0.144 | 0.228* | 0.171 | 0.215* | 0.164 | 0.201 | 0.109 |
| | (0.112) | (0.113) | (0.130) | (0.153) | (0.124) | (0.131) | (0.116) | (0.118) | (0.130) | (0.149) |
| $\mathbb{1}_i * \Delta TR_{it-2}$ | 0.481 | 0.210 | 0.190 | -0.023 | 0.016 | -0.256 | 0.173 | -0.046 | 0.187 | 0.286 |
| | (1.979) | (1.026) | (0.310) | (0.349) | (0.186) | (0.225) | (0.490) | (0.386) | (0.210) | (0.232) |
| $\Delta R_{it}$ | -0.338 | -0.948** | -0.362 | -0.953** | -0.335 | -1.037** | -0.342 | -0.955** | -0.374 | -1.000*** |
| | (0.255) | (0.382) | (0.364) | (0.378) | (0.352) | (0.529) | (0.260) | (0.389) | (0.379) | (0.379) |
| $\mathbb{1}_i * \Delta R_{it}$ | | | -0.400 | -3.398 | -0.094 | 0.339 | | | | |
| | | | (4.598) | (4.110) | (0.814) | (1.124) | | | | |
| $\Delta R_{it-1}$ | 0.289 | 0.069 | 0.267 | 0.055 | 0.292 | 0.071 | 0.292 | 0.067 | 0.262 | 0.040 |
| | (0.190) | (0.310) | (0.182) | (0.316) | (0.288) | (0.391) | (0.199) | (0.312) | (0.183) | (0.322) |
| $\mathbb{1}_i * \Delta R_{it-1}$ | | | 4.625 | -13.104 | -0.044 | -0.036 | | | | |
| | | | (56.687) | (50.391) | (9.006) | (11.648) | | | | |
| $\Delta R_{it-2}$ | -0.224 | -0.426 | -0.208 | -0.433 | -0.226 | -0.407 | -0.226 | -0.419 | -0.208 | -0.460 |
| | (0.213) | (0.655) | (0.210) | (0.623) | (0.333) | (0.793) | (0.212) | (0.652) | (0.222) | (0.636) |
| $\mathbb{1}_i * \Delta R_{it-2}$ | | | 5.943 | -9.440 | 1.294 | -1.483 | | | | |
| | | | (36.028) | (38.201) | (5.794) | (12.188) | | | | |
| $\Delta Y_{it}$ | -0.007 | -0.033 | -0.004 | -0.026 | -0.007 | -0.032 | -0.007 | -0.032 | -0.005 | -0.028 |
| | (0.017) | (0.026) | (0.014) | (0.021) | (0.018) | (0.029) | (0.018) | (0.027) | (0.014) | (0.022) |
| $\mathbb{1}_i * \Delta Y_{it}$ | 0.025 | 0.029 | 0.021 | -0.113** | 0.021 | 0.024 | 0.023 | 0.024 | -0.009 | 0.001 |
| | (0.027) | (0.038) | (0.046) | (0.050) | (0.026) | (0.042) | (0.024) | (0.041) | (0.050) | (0.078) |
| $\Delta Y_{it-1}$ | 0.039 | 0.031* | 0.033 | 0.023* | 0.039 | 0.033* | 0.039 | 0.031* | 0.033 | 0.023 |
| | (0.025) | (0.017) | (0.020) | (0.014) | (0.026) | (0.019) | (0.026) | (0.017) | (0.021) | (0.015) |
| $\mathbb{1}_i * \Delta Y_{it-1}$ | -0.033 | -0.031 | -0.046 | 0.030 | -0.033 | -0.031 | -0.036 | -0.027 | -0.024 | 0.001 |
| | (0.028) | (0.028) | (0.070) | (0.079) | (0.031) | (0.031) | (0.029) | (0.026) | (0.080) | (0.103) |
| $\Delta Y_{it-2}$ | -0.005 | 0.024** | -0.010 | 0.011 | -0.005 | 0.025* | -0.006 | 0.024* | -0.009 | 0.011 |
| | (0.016) | (0.012) | (0.012) | (0.011) | (0.016) | (0.013) | (0.016) | (0.013) | (0.012) | (0.012) |
| $\mathbb{1}_i * \Delta Y_{it-2}$ | -0.005 | -0.029* | 0.032 | 0.028 | -0.001 | -0.026 | 0.000 | -0.029* | -0.029 | 0.021 |
| | (0.018) | (0.017) | (0.050) | (0.046) | (0.018) | (0.017) | (0.018) | (0.016) | (0.044) | (0.036) |
| $\mathbb{1}_i$ | 0.006 | -0.079* | -0.005 | 0.039 | 0.005 | -0.092** | 0.007 | -0.062 | -0.013 | -0.002 |
| | (0.017) | (0.046) | (0.037) | (0.068) | (0.017) | (0.042) | (0.014) | (0.040) | (0.014) | (0.069) |
| Constant | -0.006 | 0.125*** | -0.003 | 0.108*** | -0.006 | 0.144*** | -0.007 | 0.128*** | -0.002 | 0.114*** |
| | (0.011) | (0.030) | (0.012) | (0.034) | (0.013) | (0.037) | (0.012) | (0.033) | (0.011) | (0.032) |
| Observations | 288 | 288 | 288 | 288 | 288 | 288 | 288 | 288 | 288 | 288 |
| R-squared | 0.410 | 0.167 | 0.398 | 0.154 | 0.412 | 0.173 | 0.409 | 0.163 | 0.397 | 0.138 |

Some of the groups of similar provinces never received royalties. In these cases, the interactions with $\Delta R_{it}$ could not be constructed. Bootstrap clustered standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

it affects 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 debt decrease by 0.5 centavos and only two periods later.

Finally, the remaining coefficients are very similar to those in our preferred specification. We thus conclude that differences in economic size are not introducing any bias that could modify the results.

**Poor provinces** Although the shares $\theta_i$ were not correlated with the provincial poverty index near 1988, one may still think that poor provinces tend to expend more out of an increase in their revenues because their populations have more needs than those of wealthier jurisdictions. In the same line, economic shocks that lower the national tax collection may disproportionately affect the demand for anti-poverty programs, independently of the Coparticipation regime. Indeed, if poor provinces are more easily affected by a national crisis, this can push upwards the need of poverty aid, attenuating the resulting decrease in public expenditures there.

To test whether this actually happens, we define a province as poor whenever its average poverty index during 1988-2003 was above 20 percent. Therefore, in this case, the set $\Omega_2 = \{$Chaco, Formosa, Jujuy, Misiones, Santiago del Estero, Tucumán$\}$.

We observe that poor provinces behave like wealthier ones when they face shocks to Coparticipation transfers or royalties. The only difference is that they reduce their debt by 14 centavos after a one peso increase in their GPP. This result can be consistent with the fact that such increases lower the demand for social insurance programs more sharply in poor provinces than in others, *ceteris paribus*.[39]

**Most populous provinces** In Appendix 7.3, we show that the only socio-economic indicator in 1988 that is positively correlated with the shares $\theta_i$ is population. Hence, we may believe that, all else equal, provinces with larger populations tend to expend more out of their different revenues. We define as populous provinces with more than one million inhabitants, and so

$$\Omega_3 = \{\text{Buenos Aires, CABA, Córdoba, Entre Ríos, Mendoza, Salta, Santa Fe, Tucumán}\}.$$

[39] Albeit Salta is a poor province, we do not incorporate it into the set $\Omega_2$. If we nevertheless consider Salta as poor and run the regressions, the results do not change substantially. The exception is the estimated coefficient of $\mathbb{1}_i * \Delta R_{it}$ which, keeping a very high value (-3.455), becomes statistically significant. We attribute this change to the fact that Salta is also a hydrocarbon-producing province.

Almost all coefficients of the interaction terms between the dummy and changes in revenues are not statistically significant, implying that the reactions to changes in public revenues are similar between the populous provinces and the others. The unique difference is that these provinces expend more than the others after a lagged increase in Coparticipation transfers. Although they seem to have a different pattern of intertemporal reactions to these changes, we cannot reject the null hypothesis that their accumulated effects are similar to those of the other provinces.

**Provinces with high density** Following Ladd (1992), population density is often used in the local public finance literature as a proxy for the cost of providing local services. Hence, more dense provinces should react differently than others when facing shocks to their public revenues. To address this potential bias, we define the set of most dense provinces $\Omega_4 = \{$Buenos Aires, CABA, Córdoba, Entre Ríos, Misiones, Santa Fe, Tucumán$\}$.

These provinces react like the others when they face a shock to both revenue sources, except a decrease in debt after a two-period lagged change in GPP. A possible explanation is that the four biggest provinces may explain this reaction, as previously stated.

As the remaining coefficients are very similar to those in Panel (C) in Table 6, we conclude that differences in provincial density is not introducing any bias that could modify the results.

**Provinces that depend heavily on Coparticipation transfers** In some provinces, Coparticipation transfers account for a large percent of their revenues. Therefore, one may think that facing a shock to this source of public income, these provinces may react differently than the others. To verify if this conjecture holds, we characterize a province as heavily dependent on Coparticipation transfers whenever, on average during the period 1988-2003, 80 percent or more of its revenue comes from the tax-sharing regime. Hence,

$$\Omega_5 = \{\text{Catamarca, Chaco, Corrientes, Formosa, Santiago del Estero}\}.$$

We do not observe any difference between these provinces' reactions and those of the others. Moreover, as other coefficients do not change in a significant way, we conclude that differences in provincial dependence towards Coparticipation transfers is not introducing any bias in our preferred estimations.

#### 4.1.3 Particular provinces

In Section 6 of the Online Appendix, we report the results of the regressions when we drop from the sample four particular provinces, one by one: Santiago del Estero, La Rioja, Buenos Aires, and Salta. The reasons to analyze if these provinces have a particular impact on our regressions are the following. Santiago del Estero is the province that increased its own tax collection the most between 1988 and 2003. Meanwhile, La Rioja received large amounts of discretionary transfers. After some political negotiations in 1991 and 1992, Buenos Aires obtained additional resources. Finally, Salta is the only poor hydrocarbon-producing province.

In these regressions, some coefficients of our preferred specification loose part of their statistical significance, which we attribute to the decrease in the number of clusters. Despite this fact, all keep their economic value, implying that excluding these provinces from the data has no impact on the results presented in panel (C) in Table 6.

We conclude that the results regarding the different smoothing behavior with respect to shocks to Coparticipation transfers and royalties are robust to many different specifications of our basic regressions.

# 5 Fiscal reactions in hydrocarbon-producing provinces

Although we instrument royalties, we can still suspect that the estimated reactions to their changes in Table 6 may be biased downwards, because they capture the average response of all provinces in a situation where only a few of them receive this type of funds. Moreover, we can also argue that provinces receiving royalties from natural resources may be different from the other 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.[40] To evaluate these hypothesis, in Table (10) we estimate equations (3) and (4) using 2SLS, first for hydrocarbon-producing provinces and then for the others.[41]

[40] 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.

[41] As we did for the previous regressions, we also estimate these specifications with time fixed effects. The most important result concerns the fact that, for hydrocarbon-producing provinces, no time dummy is statistically significant in the second stage; whereas the dummies for 2001 and 2003 are statistically significant

In the first stage, the Kleibergen-Paap Wald statistic is lower for hydrocarbon-producing provinces than for the others.[42] Nevertheless, the Anderson-Rubin test validates the inference of the second stage, for both types of provinces.

In the second stage, the estimated reactions to contemporaneous changes in Coparticipation transfers seem to be similar between these two groups of provinces: Both spend a large fraction of a one peso increase in this source of revenue increasing public consumption. We use a Wald chi-square test to determine if these estimated coefficients are different: the value of the statistic is 0.9, with a $p$-value of 0.34. Hence, we cannot reject the null hypothesis that the coefficients $\widehat{\alpha}_1^G$, estimated separately for hydrocarbon-producing provinces and for the others, are equal. With respect to debt reactions to those same shocks, the estimated coefficients $\widehat{\alpha}_1^D$ are one and the other statistically non significant.

Moreover, there is no difference between these two groups of provinces with respect to their lack of reaction to contemporaneous and lagged shocks to GPP.

Hence, we can establish that, when they face shocks to Coparticipation transfers or to their GPP, hydrocarbon-producing provinces behaved like the others.

But the former reacted differently -qualitatively and quantitatively- to shocks to their other source of revenue: When faced with a one peso increase in royalties, they channeled much of the adjustment towards a large decrease in debt, approximately 95 centavos, rather than modifying public consumption. This estimated coefficient is 25 percent higher than the corresponding one in panel (C) in Table 6, confirming that the latter is biased downwards, due to the abomentioned averaging effect. Moreover, the magnitude of this reaction suggests that royalties' savings are almost instantaneous in hydrocarbon-producing provinces.

We conclude that hydrocarbon-producing provinces spent much out of increases in Coparticipation transfers, while they saved rises in royalties.[43] In the next section, we provide two alternative explanations for why these provinces might have behaved in this way, and we analyze their plausibility. Finally, we try to find in the data any evidence of the mechanisms mentioned in these explanations.

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to explain, first an increase and then a decrease, in the other provinces' debts.

[42] In Appendix 7.7, we present further evidence that provides support for the validity of the exclusion restriction of the instrument for royalties $Z_{it}$.

[43] In Section 7 of the Online Appendix, we present narrative evidence supporting the last result.

Table 10: Fiscal responses, hydrocarbon-producing vs. other provinces

| | Hydrocarbon-producing provinces | | Other provinces | |
|---|---|---|---|---|
| | $\Delta G_{it}$ | $\Delta D_{it}$ | $\Delta G_{it}$ | $\Delta D_{it}$ |
| $\Delta TR_{it}$ | 0.729*** | -0.357 | 0.816*** | -0.038 |
| | (0.154) | (0.252) | (0.055) | (0.137) |
| $\Delta TR_{it-1}$ | 0.152 | 0.01 | 0.268** | -0.043 |
| | (0.204) | (0.350) | (0.114) | (0.174) |
| $\Delta TR_{it-2}$ | -0.052 | -0.141 | 0.4*** | 0.22 |
| | (0.212) | (0.256) | (0.093) | (0.165) |
| $\Delta R_{it}$ | -0.277 | -0.951** | -3.71 | -19.032 |
| | (0.274) | (0.414) | (6.571) | (16.692) |
| $\Delta R_{it-1}$ | 0.100 | -0.093 | 1.128 | -8.967 |
| | (0.170) | (0.234) | (4.630) | (6.871) |
| $\Delta R_{it-2}$ | -0.244 | -0.515 | 2.211 | -2.334 |
| | (0.327) | (0.404) | (4.687) | (9.655) |
| $\Delta Y_{it}$ | 0.005 | -0.024 | 0.007 | -0.019 |
| | (0.023) | (0.038) | (0.011) | (0.020) |
| $\Delta Y_{it-1}$ | 0.029 | 0.024 | 0.005 | 0.018 |
| | (0.025) | (0.021) | (0.008) | (0.015) |
| $\Delta Y_{it-2}$ | -0.020 | 0.015 | -0.004 | -0.004 |
| | (0.021) | (0.016) | (0.009) | (0.009) |
| Constant | 0.015 | 0.192*** | -0.007 | 0.089*** |
| | (0.022) | (0.054) | (0.004) | (0.026) |
| Anderson-Rubin test | 52.84*** | 3.88* | 83.78*** | 2.78* |
| Number of clusters | 8 | 8 | 16 | 16 |
| Observations | 104 | 104 | 208 | 208 |
| $R^2$ | 0.422 | 0.281 | 0.505 | -0.035 |

Bootstrap clustered standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

## 5.1 Plausible explanations for the observed behavior

### 5.1.1 Volatility of different sources of public income

One explanation for these contrasting fiscal reactions is that authorities in hydrocarbon-producing provinces may perceive shocks to royalties as being more volatile than those to Coparticipation transfers, all else equal. If this were indeed the case, a precautionary savings argument, as pointed out by Vegh and Vuletin (2015), could be made to explain these different reactions.[44]

To check if this argument holds, first we need to verify if the volatility of royalties was higher than that of Coparticipation transfers from 1988 to 2003. In Appendix 7.8 we compare them in three different ways. First, for each hydrocarbon-producing province and each source of revenue, we compute its average coefficient of variation. We corroborate that the coefficient of variation of royalties is higher than that of Coparticipation transfers. Second, when we average among all hydrocarbon-producing provinces, the accumulated coefficient of variation of royalties is, year after year, higher than of Coparticipation transfers.

But as these results only deal with unconditional volatility, we can go one step further. Acknowledging that provincial authorities perceive that their two main sources of public income follow different random paths (as we have previously assumed), we estimate various specifications of these stochastic processes and choose the best, according to information criteria. We find that royalties follow a mean-reverting process, while Coparticipation transfers evolve according to an autoregressive process of order 2; and also that the former present the highest estimated coefficient of variation of the error term.

Therefore, both unconditionally and conditionally, royalties are more volatile than Coparticipation transfers, which makes the aforementioned argument on precautionary savings plausible.

### 5.1.2 Intergenerational concerns and the nonrenewable nature of hydrocarbons

Another explanation for why hydrocarbon-producing provinces spent less any increase in royalties could be intergenerational considerations and concerns over hydrocarbons being nonrenewable resources. Even absent price and geological uncertainty, provincial

[44] 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.

governments can consider oil and gas reserves as an income-generating asset. In a standard life-cycle model, a utilitarian provincial government will use hydrocarbon royalties to maximize the welfare over an infinite 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. In particular, during a mature stage of production, far from the initiation of exploitation but also from depletion, provincial governments optimize saving from their royalties.

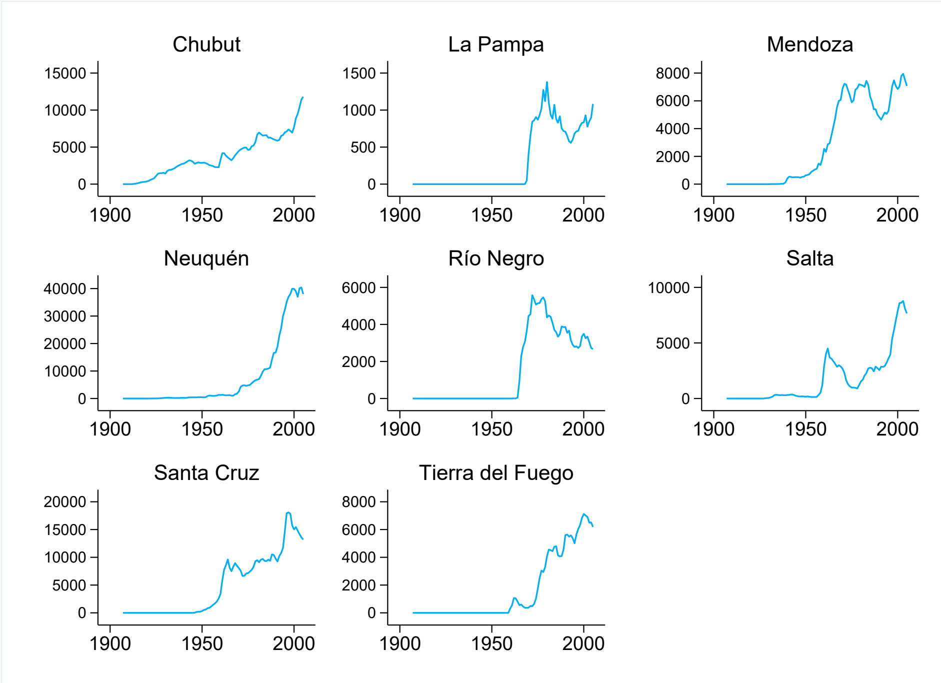
Of course, optimal planning is more complicated in real life, given price and geological uncertainty. Barnett and Ossowski (2003) explained that the best-known strategy for hydrocarbon-producing governments is a fiscal policy that preserves their hydrocarbon and non-hydrocarbon wealth, which implies that in each period, public consumption should be limited to permanent income -an argument that is familiar from the tax smoothing literature (Barro 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 9, where we plot the provinces' historical production of hydrocarbons.[45,46] Clearly, no hydrocarbon-producing province in 1988 was at an initial stage of production.

[45]In Section 8 of the Online Appendix, we explain in detail how we build the data depicted in Figures 9 and 10.

[46]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.

Figure 9: Historical production of hydrocarbons, by province




Production is measured in housand of $m^3$ of oil equivalents. Sources: IAP (1967), *Anuario de Combustibles*, Instituto del Petróleo y del Gas and own calculations.

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 neither the case by constructing a depletion index for the years 1970-2003. Each hydrocarbon-producing province $j$ is slotted into the index $DI_{jt}$, and

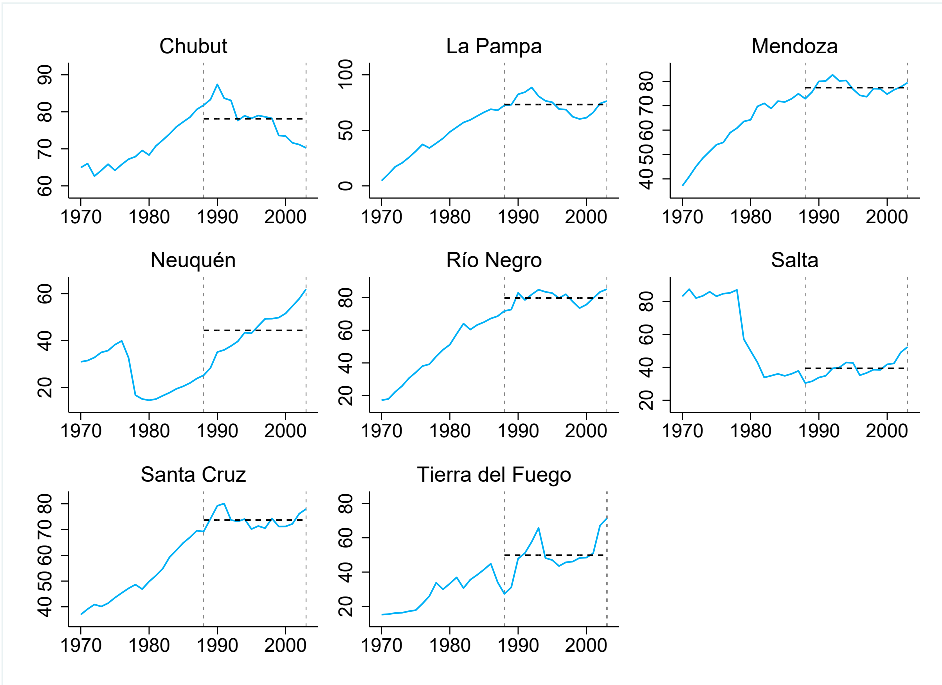
$$DI_{jt} \equiv \frac{AP_{jt}}{TR_{jt}} = \frac{\sum_{s=0}^{t} q_{js}}{\sum_{s=0}^{t} q_{js} + R_{jt}}$$

is the ratio of accumulated hydrocarbon production $AP_{jt}$ (from the beginning of exploitation up to year $t$) to total known reserves in $t$, $TR_{jt}$.[47] Figure 10 shows the depletion index $DI_{jt}$ for the full range of years and the average between 1988 and 2003.[48]

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

[48]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 in Argentina.

Figure 10: Index of hydrocarbons depletion, by province




The depletion index is measured in percent. Sources: *Anuario de Combustibles* and own calculations.

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 suggest an end stage of the production curve, it is 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 five 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

$$RRR_{jt} \equiv \frac{d_{jt}}{q_{jt}},$$

which is the ratio between discoveries in year $t$ (i.e., the amount of proved reserves added to the stock), $d_{jt}$, and production in the same year $q_{jt}$. A result that is greater than one means that more hydrocarbons are discovered than extracted, so production is not at a depletion stage. Figure 15 in Appendix 7.9 depicts the rate $RRR_{jt}$ for the eight hydrocarbon-producing provinces, between 1988 and 2003.

There, we can see that this rate was above one for most of the years. In fact, for these provinces, we cannot reject the null hypothesis that their average reserve-replacement rate was equal to one, except for the case of Chubut, where it was greater than this threshold. Therefore, despite having an average depletion index near 80 percent, Chubut, La Pampa, Mendoza, Río Negro, and Santa Cruz were not at the final stage of hydrocarbons production.

We conclude that hydrocarbon-producing provinces were, during 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.

## 5.2 Evidence of these explanations in our data

Now, we try to find suggestive evidence of whether any of these potential channels are operating in our data. To do that, we incorporate into the first two regressions of Table 10 variables that are related to these mechanisms.

We were not able to detect any effect of the different volatilities of both revenue sources on the fiscal reactions of hydrocarbon-producing provinces.[49] But things are different concerning the non-renewable nature of their royalties. We find a substantial impact of changes in the depletion index on how these provinces react to shocks to this revenue source. Table 11 presents the results.

Although the level of $\Delta DPI_{jt}$ has no effect on the provincial policies, the estimated coefficients of the interaction $\Delta DPI_{jt}.\Delta R_{jt}$ are negative and significant in both regressions in panel (H). The total effect of a one peso increase in royalties on $\Delta G_{jt}$ is non-significant: it is equal to $(-0.096) + (-0.278) = -0.374$, with a $p$-value of 0.16. On the other hand, this same effect on $\Delta D_{jt}$ is significant: it amounts to $(-0.773) + (-0.359) = -1.132$, with a $p$-value of 0.04.

[49] We present these results in Section 9 of the Online Appendix.

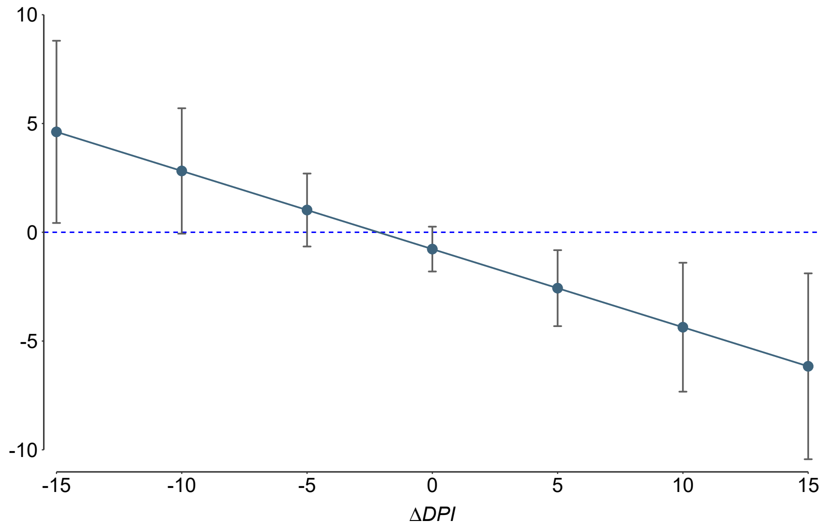
Table 11: Depletion and fiscal responses in hydrocarbon-producing provinces

| | (G) | | (H) | |
|---|---|---|---|---|
| | $\Delta G_{jt}$ | $\Delta D_{jt}$ | $\Delta G_{jt}$ | $\Delta D_{jt}$ |
| $\Delta TR_{jt}$ | 0.717*** | -0.478 | 0.560*** | -0.682** |
| | (0.147) | (0.298) | (0.172) | (0.316) |
| $\Delta TR_{jt-1}$ | 0.255* | 0.015 | 0.140 | -0.134 |
| | (0.145) | (0.161) | (0.129) | (0.164) |
| $\Delta TR_{jt-2}$ | -0.059 | -0.184 | -0.097 | -0.233 |
| | (0.225) | (0.311) | (0.216) | (0.316) |
| $\Delta R_{jt}$ | -0.255 | -0.978* | -0.096 | -0.773 |
| | (0.277) | (0.559) | (0.300) | (0.525) |
| $\Delta R_{jt-1}$ | 0.172 | -0.022 | 0.119 | -0.090 |
| | (0.136) | (0.164) | (0.147) | (0.169) |
| $\Delta R_{jt-2}$ | -0.252 | -0.571 | -0.224 | -0.535 |
| | (0.311) | (0.483) | (0.291) | (0.456) |
| $\Delta Y_{jt}$ | -0.001 | -0.025 | 0.004 | -0.018 |
| | (0.023) | (0.030) | (0.015) | (0.023) |
| $\Delta Y_{jt-1}$ | 0.020 | 0.018 | 0.026 | 0.025 |
| | (0.021) | (0.023) | (0.022) | (0.022) |
| $\Delta Y_{jt-2}$ | -0.016 | 0.013 | -0.021 | 0.008 |
| | (0.018) | (0.020) | (0.015) | (0.020) |
| $\Delta DPI_{jt}$ | -0.008 | -0.011 | -0.005 | -0.007 |
| | (0.005) | (0.012) | (0.005) | (0.008) |
| $\Delta DPI_{jt} * \Delta R_{it}$ | | | -0.278* | -0.359** |
| | | | (0.155) | (0.140) |
| Constant | 0.014 | 0.185*** | 0.032 | 0.208*** |
| | (0.020) | (0.050) | (0.025) | (0.061) |
| Number of clusters | 8 | 8 | 8 | 8 |
| Observations | 104 | 104 | 104 | 104 |
| $R^2$ | 0.476 | 0.254 | 0.549 | 0.353 |

The index $j$ represents a hydrocarbon-producing province. Bootstrap clustered standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

To visualize the negative relation that our regressions seem to convey, Figure 11 illustrates, for given values of $\Delta DPI$, the average marginal impact of royalties on the debt reaction, with its corresponding 95 percent confidence interval.

Figure 11: Average marginal effects of royalties




For example, if $\Delta DPI = -10$ percentage points, an hydrocarbon-producing province reacts to a one peso increase in royalties by increasing debt by $(-0.773) + (-10).(-0.359) =$ 2.817 pesos. Even though this value seems high, its confidence interval includes 0. But for increases in the depletion index larger than one percentage point, the reactions are to decrease debt, in a statistically significant way.[50] Therefore, the figure confirms the following relationship: the higher the value of $\Delta DPI_{jt}$, the larger the saving reaction of hydrocarbon-producing provinces when they face a one peso increase in royalties. To the very best of our knowledge, this relationship has never been noted in the local public finance literature, and is consistent with optimal fiscal reactions in mature hydrocarbon producing jurisdictions.

# 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

[50] We also observe a significant average increase in debt when the depletion index decreases by more than 11 percentage points.

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 debt and spending behavior of Argentine provinces. The most important type of transfer that provinces received from the national government came from the Coparticipation tax-sharing regime. In addition, we examine provinces' debt and 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.

To overcome potential threats to our identification strategy, we adopt a Bartik-like instrumental variables approach. We instrument Coparticipation transfers, using fixed provincial shares interacted with yearly changes to the common pool of taxes collected by the national government. We also instrument royalties, with an index of provincial hydrocarbons abundance in the pre-estimation period interacted with yearly changes in the international oil price.

Our main results relate to the years of 1988-2003, when the regulations of the tax sharing regime and royalties were persistently enforced, and the economic intervention of the national government in the provinces was limited. On average, provinces used 76 centavos out of a one peso increase in their Coparticipation transfers to raise public consumption, and 22 centavos to reduce their debt. On top of that, hydrocarbon-producing provinces employ almost any increase in royalties entirely to lower their debt. These results are robust to different specifications of the basic regressions we run.

To potentially explain why hydrocarbon-producing provinces save more of royalties than of Coparticipation funds, we emphasize the higher volatility of royalties (relative to the other transfers) and the exhaustible nature of these revenues. Although we could not detect any evidence of the former mechanism in our data, we find a positive relationship between changes in the hydrocarbons depletion index and provincial savings.

# 7 Appendix

## 7.1 Legal coefficients of the secondary distribution

To explain how the legal coefficients set by Law 23548 were determined, we need to describe some characteristics of the tax-sharing regimes that were in place before 1988, and their evolution. In 1973, the first law to uniformly regulate the Argentine tax-sharing regime was 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 index (25 percent), and population dispersion (i.e., inverse of density) (10 percent). Therefore, under Law 20221, Coparticipation transfers depended in some way on provincial policies.[51]

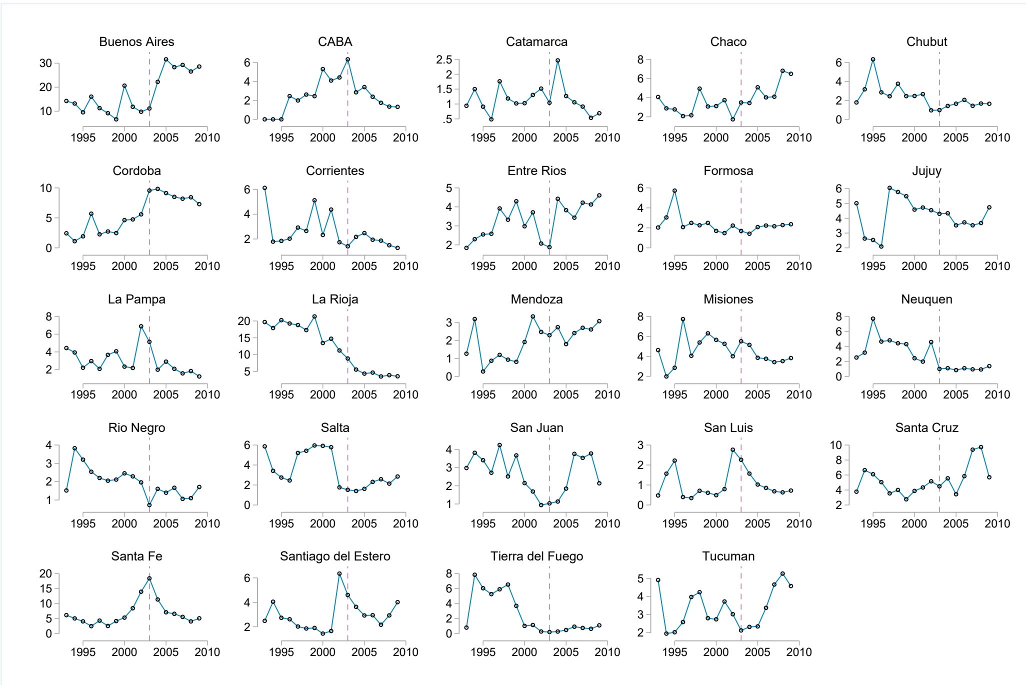
Although a new Coparticipation law should have been passed in 1983, the recently elected Radical government lacked the political power to engage in such a task and decided to keep Law 20221 in place. At the end of 1985, this law finally expired. As no consensus to approve a new law emerged, provinces 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 Congress finally enacted Law 23548 in January 1988, the legal coefficients that appeared in the law replicated the shares that had been obtained by each province during the previous months.

## 7.2 The use of discretionary transfers

After 2003, discretionary transfers distributed by the national government represented a higher fraction of provincial incomes than they had been previously. But this does not necessarily imply that the allocation of these transfers was politically motivated. One could argue that their distribution may have replicated the assignment of Coparticipation transfers. Figure 12 proves that this was not the case, showing the percent of discretionary transfers received by each province (out of the total amount of discretionary transfers allocated to all provinces), from 1993 to 2009.

[51] Indeed, the development gap index was built using, as explanatory variables, housing quality, cars per inhabitant, and degree of education.

Figure 12: Discretionary transfers (as percent of all discretionary transfers)




The vertical line indicates the year 2003. Source: Artana et al. (2012)

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 participation decrease.

## 7.3 Correlations between provincial coefficients $\theta_i$ and socioeconomic indicators in 1988

As a possible way to justify the exclusion restriction of our instrument $W_{it}$, we examine how much the shares $\theta_i$ are correlated with other potential confounders in 1988. We consider the following socioeconomic provincial indicators: poverty index, population, density and per capita GPP. These indicators were employed in setting Coparticipation transfers under the previous Law 20221 (1973) (See Appendix 7.1), and they are currently used in the local public finance literature to explain intergovernmental grants. Table 12 exhibits the results.

Table 12: Correlations between the shares $\theta_i$ and provincial indicators

| | Correlation coef. | p-value |
|---|---|---|
| Poverty index (1991) | -0.209 | 0.327 |
| Population (1988) | 0.946 | 0.000 |
| Density (1988) | -0.090 | 0.676 |
| GPP/hab (1988) | -0.205 | 0.335 |

There is no significant correlation between the shares $\theta_i$ and the poverty index, density or per capita GPP. We do find a positive and significant correlation with population, which is expected as a remnant from previous tax-sharing regimes. This implies a potential concern for endogeneity, which is addressed in Section 4.1.2.

## 7.4 The instrument $Z_{it}$ and provincial economic indicators

To satisfy the exclusion restriction, the instrument $Z_{i,t}$ must affect provincial public expenditures and debt only through royalties.

In the following tables, we test whether our instrument was correlated with contemporaneous changes in some economic indicators at the provincial level, during the period under analysis: per capita GPP and unemployment.[52] Table 13 presents the results for all provinces, while Table 14 evaluates them only in hydrocarbon-producing ones.

Table 13: Instrument and economic indicators, all provinces

| | GPP | Unemployment |
|---|---|---|
| $Z$ | -0.001 | 0.005 |
| | (0.002) | (0.006) |
| Constant | 0.089 | 0.412*** |
| | (0.116) | (0.058) |
| Observations | 360 | 345 |
| $R^2$ | 0.001 | 0.01 |

OLS estimation, Bootstrap clustered standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

[52]Due to the lack of disaggregated data at the provincial level, we could not evaluate these impacts on the hydrocarbon sector.

Table 14: Instrument and economic indicators, hydrocarbon-producing provinces

| | GPP | Unemployment |
|---|---|---|
| $Z$ | -0.001 | 0.005 |
| | (0.002) | (0.003) |
| Constant | -0.064 | 0.365*** |
| | (0.308) | (0.085) |
| Observations | 120 | 105 |
| $R^2$ | 0.002 | 0.042 |

OLS estimation, Bootstrap clustered standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

We observe that our instrument is not correlated with these economic indicators. These results do not seem to validate the presumption that a peak in the international oil price boosts the local economic activity.

## 7.5 Fiscal reactions in all provinces under different dynamic specifications

We have estimated first and second stage instrumental variables of equations (3) and (4), with different dynamic specifications. The second stage results appear in Table 15.

When we consider only contemporaneous changes in all dependent variables, this specification faces a couple of drawbacks. The Kleibergen-Paap Wald statistic is non significant in the first stage. Moreover, the AIC and BIC statistics are much higher than those of the other specifications. Finally, the estimated coefficient of the change in debt when facing a one-peso increase in royalties loses its statistical significance. In fact, we suspect that these regressions face an omitted-variable bias,[53] so the estimations could be inconsistent.

When we incorporate lagged changes in all regressors, the estimated coefficients change (some substantially) and become closer. The three last specifications have comparable first stages. According to Akaike and Bayesian information criteria, the specification with three-periods lagged changes in all regressors should be chosen. But we prefer the one

[53] Indeed, in all specifications presented in Table 6, many coefficients of the lagged changes of the independent variables are statistically significant.

Table 15: Fiscal responses with different number of lags in all provinces

| | No lags | | One lag | | Two lags | | Three lags | |
|---|---|---|---|---|---|---|---|---|
| | $\Delta G_{it}$ | $\Delta D_{it}$ | $\Delta G_{it}$ | $\Delta D_{it}$ | $\Delta G_{it}$ | $\Delta D_{it}$ | $\Delta G_{it}$ | $\Delta D_{it}$ |
| $\Delta TR_{it}$ | 0.961*** | 0.002 | 0.813*** | -0.275* | 0.760*** | -0.216* | 0.889*** | -0.180 |
| | (0.153) | (0.328) | (0.152) | (0.141) | (0.074) | (0.125) | (0.103) | (0.131) |
| $\Delta TR_{it-1}$ | | | 0.312*** | -0.032 | 0.209*** | 0.059 | 0.277*** | 0.216*** |
| | | | (0.093) | (0.188) | (0.070) | (0.088) | (0.085) | (0.083) |
| $\Delta TR_{it-2}$ | | | | | 0.092 | 0.007 | 0.290** | 0.119 |
| | | | | | (0.157) | (0.157) | (0.117) | (0.187) |
| $\Delta TR_{it-3}$ | | | | | | | 0.097 | 0.322** |
| | | | | | | | (0.114) | (0.134) |
| $\Delta R_{it}$ | -0.298 | -2.188 | -0.294 | -1.315*** | -0.231 | -0.764** | -0.320 | -0.933** |
| | (1.199) | (3.944) | (0.392) | (0.489) | (0.261) | (0.343) | (0.270) | (0.368) |
| $\Delta R_{it-1}$ | | | 0.245 | -0.184 | 0.147 | -0.055 | 0.155 | -0.026 |
| | | | (0.173) | (0.288) | (0.173) | (0.300) | (0.201) | (0.389) |
| $\Delta R_{it-2}$ | | | | | -0.305 | -0.575* | -0.230 | -0.537 |
| | | | | | (0.198) | (0.331) | (0.450) | (0.574) |
| $\Delta R_{it-3}$ | | | | | | | 0.284* | 0.260 |
| | | | | | | | (0.147) | (0.311) |
| $\Delta Y_{it}$ | 0.015* | -0.00043 | 0.002 | -0.017 | 0.002 | -0.022 | -0.010 | -0.035 |
| | (0.009) | (0.024) | (0.012) | (0.020) | (0.011) | (0.017) | (0.013) | (0.024) |
| $\Delta Y_{it-1}$ | | | 0.019 | 0.012 | 0.026 | 0.019* | 0.034 | 0.019** |
| | | | (0.013) | (0.016) | (0.016) | (0.011) | (0.021) | (0.0147) |
| $\Delta Y_{it-2}$ | | | | | -0.015 | 0.008 | -0.013 | 0.003 |
| | | | | | (0.013) | (0.010) | (0.010) | (0.015) |
| $\Delta Y_{it-3}$ | | | | | | | 0.004 | -0.003 |
| | | | | | | | (0.022) | (0.020) |
| Constant | -0.003 | 0.127*** | 0.009* | 0.141*** | -0.001 | 0.118*** | -0.002 | 0.114*** |
| | (0.005) | (0.026) | (0.005) | (0.025) | (0.007) | (0.024) | (0.008) | (0.028) |
| Anderson-Rubin test | 17.51*** | 16.08*** | 22.64*** | 4.69** | 104.19*** | 7.43** | 36.56*** | 5.00** |
| Observations | 360 | 360 | 336 | 336 | 312 | 312 | 288 | 288 |
| R-squared | 0.240 | -0.346 | 0.375 | 0.125 | 0.427 | 0.185 | 0.397 | 0.181 |
| AIC[a] | -127.7 | 231.2 | -188.5 | 52.6 | -195.4 | 15.70 | -213.6 | 3.80 |
| BIC[b] | -112.2 | 246.7 | -161.7 | 79.3 | -158 | 53.1 | -166 | 51.4 |

Bootstrap clustered standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. [a] Akaike information criterion [b] Bayesian information criterion.

Table 16: Main estimations with time fixed effects: first stage

| | $\Delta R_{it}$ | $\Delta Tr_{it}$ |
|---|---|---|
| $\Delta TR_{it-1}$ | -0.119 | 0.120 |
| | (0.115) | (0.175) |
| $\Delta TR_{it-2}$ | 0.071 | 0.068 |
| | (0.076) | (0.050) |
| $\Delta R_{it-1}$ | 0.234 | 0.143 |
| | (0.163) | (0.097) |
| $\Delta R_{it-2}$ | -0.026 | -0.171** |
| | (0.123) | (0.073) |
| $\Delta Y_{it}$ | -0.007 | -0.009 |
| | (0.014) | (0.006) |
| $\Delta Y_{it-1}$ | 0.011 | -0.009* |
| | (0.009) | (0.005) |
| $\Delta Y_{it-2}$ | -0.003 | 0.008** |
| | (0.004) | (0.003) |
| $\Delta Z_{it}$ | 0.002*** | 0.000 |
| | (0.001) | (0.000) |
| $\Delta W_{it}$ | -0.061 | 0.765*** |
| | (0.104) | (0.054) |
| Constant | 0.018 | 0.097*** |
| | (0.047) | (0.017) |
| Kleibergen-Paap Wald statistic | 5.314** | |
| Number of clusters | 24 | 24 |
| Observations | 312 | 312 |
| $R^2$ | 0.475 | 0.832 |

No time dummy is significant in the royalties regression. All time dummies are statistically significant in the Coparticipation transfers regression. Bootstrap clustered standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

with two-period lagged changes because it exhibits a higher level of inference and estimated coefficients that are less extreme.

## 7.6 Fiscal reactions in all provinces with time fixed effects

We estimate equations (3) and (4) using 2SLS with time fixed effects. Results appear in Tables 16 and 17.

The Hausman test between these specifications and those that appears in panel (C) in Table 6 rejects the null hypothesis that the difference in the coefficients is not systematic. Despite this fact, we can argue against incorporating time fixed effects, for two reasons.

First, although with time dummies the results of the first stage improve with respect to those that are presented in Table 7, we face an identification problem at the second stage, due to the loss of degrees of freedom. The inference in the expenditure regression drops considerably, while, in the debt regression, all estimated coefficients completely loose their statistical significance. Second, despite the fact that some time dummies are significant in the second stage, their effect on provincial policies is difficult to understand. For example, in 1995, 1999 and 2002 Argentina faced falls in its GDP, which can explain negative reactions in expenditures or increasing debts. On the other hand, the agreement between the national government and the provinces to consolidate their debts justifies the sign observed in 2003. But for the other years, the connection between the country's macroeconomic situation and the provincial reactions is unclear.

## 7.7 Supplementary evidence in favor of the validity of the exclusion restriction of the royalties' instrument $Z_{it}$

Following Angrist et al. (2010), we perform an informal test of the exclusion restriction of $Z_{it}$. We divide the set of non-hydrocarbon-producing provinces into two groups: 1) provinces that received some royalties between 1988 and 2003, and 2) provinces that have never obtained public revenues from the exploitation of natural resources during this period.

In particular, we focus our attention on the first group: Catamarca, Corrientes, Entre Ríos, Formosa, Jujuy, Misiones and Santa Fe. For these provinces, we perform the first-stage estimations, and observe that they are less affected by our instrument $Z_{it}$ than hydrocarbon-producing provinces. Indeed, the economic and statistical significance of the coefficient of the instrument $Z_{it}$ in the royalties regression (0.001, with a significance at the five percent) is lower than for hydrocarbon-producing provinces (0.002, with a significance at the one percent).[54]

For this second group of provinces, we estimate reduced-form regressions that include all (exogenous and endogenous) regressors, as well as the instruments $W_{it}$ and $Z_{it}$. The results are presented in Table 18. In particular, the instrument $Z_{it}$ does not have an effect

[54] Why is this coefficient statistically significant if five out of seven of these provinces earn royalties from mineral exploitation and hydroelectricity generation, whose values do not depend explicitly upon the international oil price $p^*$? One possible explanation is that Formosa and Jujuy received, during some years between 1988 and 2003, few hydrocarbon royalties, which are very correlated with $Z_{it}$.

Table 17: Main estimations with time fixed effects: second stage

| | $\Delta G_{it}$ | $\Delta D_{it}$ |
|---|---|---|
| $\Delta TR_{it}$ | 0.607*** | -0.001 |
| | (0.174) | (0.286) |
| $\Delta TR_{it-1}$ | 0.134 | -0.072 |
| | (0.145) | (0.185) |
| $\Delta TR_{it-2}$ | -0.063 | -0.124 |
| | (0.172) | (0.264) |
| $\Delta R_{it}$ | -0.032 | -0.535 |
| | (0.279) | (0.385) |
| $\Delta R_{it-1}$ | 0.134 | -0.115 |
| | (0.194) | (0.295) |
| $\Delta R_{it-2}$ | -0.260 | -0.321 |
| | (0.186) | (0.329) |
| $\Delta Y_{it}$ | 0.004 | -0.00007 |
| | (0.013) | (0.023) |
| $\Delta Y_{it-1}$ | 0.012 | -0.00011 |
| | (0.018) | (0.012) |
| $\Delta Y_{it-2}$ | -0.023 | -0.017 |
| | (0.019) | (0.013) |
| Constant | 0.029 | 0.080 |
| | (0.053) | (0.060) |
| Anderson-Rubin test | 7.02*** | 1.32 |
| Number of clusters | 24 | 24 |
| Observations | 312 | 312 |
| $R^2$ | 0.507 | 0.324 |

The dummies for 1994, 1995, 1999 and 2003 are significant in the debt regression. The dummies for 1996, 2002 and 2003 are significant in the expenditure regression. Bootstrap clustered standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

on expenditure and debt reactions. This result provides another indirect support for the validity of the exclusion restriction of our instrument $Z_{it}$.

Table 18: Reduced form regressions

| | $\Delta G_{it}$ | $\Delta D_{it}$ |
|---|---|---|
| $\Delta TR_{it}$ | 1.208*** | 0.088 |
| | (0.3033) | (0.178) |
| $\Delta TR_{it-1}$ | 0.1625* | 0.055 |
| | (0.084) | (0.136) |
| $\Delta TR_{it-2}$ | 0.549*** | 0.238 |
| | (0.151) | (0.187) |
| $\Delta R_{it}$ | -1.041 | -3.374 |
| | (2.067) | (3.484) |
| $\Delta R_{it-1}$ | -0.2146 | -6.39 |
| | (3.389) | (4.684) |
| $\Delta R_{it-2}$ | 3.847 | -4.443 |
| | (3.3064) | (5.40) |
| $\Delta Y_{it}$ | -0.004 | -0.059 |
| | (0.0135) | (0.039) |
| $\Delta Y_{it-1}$ | 0.017 | 0.040 |
| | (0.027) | (0.034) |
| $\Delta Y_{it-2}$ | -0.017 | 0.029 |
| | (0.0147) | (0.026) |
| $W_{it}$ | -0.34 | -0.211 |
| | (0.225) | (0.192) |
| $Z_{it}$ | -0.0025 | -0.013 |
| | (0.009) | (0.0084) |
| Constant | -0.0031 | 0.170*** |
| | (0.007) | (0.026) |
| Number of clusters | 7 | 7 |
| Observations | 91 | 91 |
| $R^2$ | 0.585 | 0.303 |

These regressions are run for Catamarca, Corrientes, Entre Ríos, Formosa, Jujuy, Misiones and Santa Fe. Bootstrap clustered standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

## 7.8 Volatility of Coparticipation transfers and royalties in hydrocarbon-producing provinces

We compare the volatilities of Coparticipation transfers and royalties from 1988 and 2003, in three different ways.

First, Table 19 presents the provincial coefficient of variation of Coparticipation transfers and royalties, taking the average during 1988-2003. We observe that the former is always lower than the latter.

Table 19: Average coefficient of variation by source of revenue, by province

| Province | Coparticipation transfers | Royalties |
|---|---|---|
| Chubut | 0.2088 | 0.6900 |
| La Pampa | 0.1761 | 0.5061 |
| Mendoza | 0.1492 | 0.5795 |
| Neuquén | 0.1535 | 0.4102 |
| Río Negro | 0.1460 | 0.4748 |
| Salta | 0.1386 | 1.0886 |
| Santa Cruz | 0.1965 | 0.4470 |
| Tierra del Fuego | 0.3903 | 0.4394 |

Source: Dirección Nacional de Relaciones Económicas con las Provincias and own calculations.

Next, for both sources of provincial revenue, we compute the yearly accumulated coefficient of variation, starting from 1989 and taking the average among these eight provinces. Figure 13 depicts the results. Clearly, the volatility of royalties is, year after year, higher than that of Coparticipation transfers.

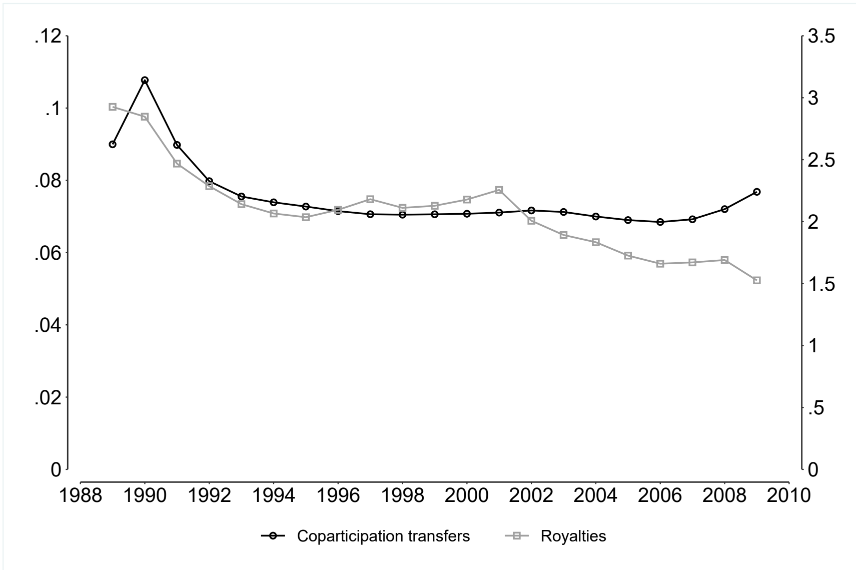
Finally, we estimate specific stochastic processes for these sources of provincial revenue, aggregating (or averaging out) the data across all provinces.[55] We postulate that these variables evolve according to autoregressive AR($p$) processes in first differences. For each type of revenue,[56] we estimate specifications with one, two, and three lags, and we compute the Breusch-Godfrey statistic corresponding to the highest lag considered. For all specifications, we also evaluate the Akaike statistic. Table 20 presents the results.

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

[55] In this last exercise, we need to consider all provinces to have sufficient observations.

[56] One may wonder whether the contemporaneous change of one source of revenue could be influenced by lagged changes of the other. In order to check if this happens, 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.

Figure 13: Comparison of average accumulated coefficients of variation, by source of revenue




The scale on the left vertical axis corresponds to the coefficient of variation of Coparticipation transfers. The scale on the right vertical axis corresponds to the coefficient of variation of royalties. Source: Dirección Nacional de Relaciones Económicas con las Provincias and own calculations.

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 empirical literature on oil prices.[57]

The next three columns deal with 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 revenues 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. Again, the highest value corresponds to royalties.

[57]See, among others, Pindyck (1999), Casassus et al. (2005), and Kilian (2009).

Table 20: Estimation of autoregressive equations in first differences for royalties and Coparticipation transfers

| | Royalties | | | Coparticipation transfers | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (1) | (2) | (3) |
| Constant | 0.029 | 0.0038 | 0.058* | 0.032 | 0.036 | 0.021 |
| | (0.027) | (0.029) | (0.031) | (0.038) | (0.035) | (0.035) |
| 1 lag | 0.034* | 0.133 | -0.008 | 0.188 | 0.222 | 0.163 |
| | (0.169) | (0.270) | (0.289) | (0.254) | (0.234) | (0.290) |
| 2 lags | | 0.288 | 0.032 | | -0.637* | -0.510* |
| | | (0.189) | (0.270) | | (0.260) | (0.262) |
| 3 lags | | | 0.255 | | | -0.208 |
| | | | (0.207) | | | (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 parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. [a]Akaike information criterion. [b]Breusch-Godfrey statistic for the highest lag. [c]Coefficient of variation of the error term.

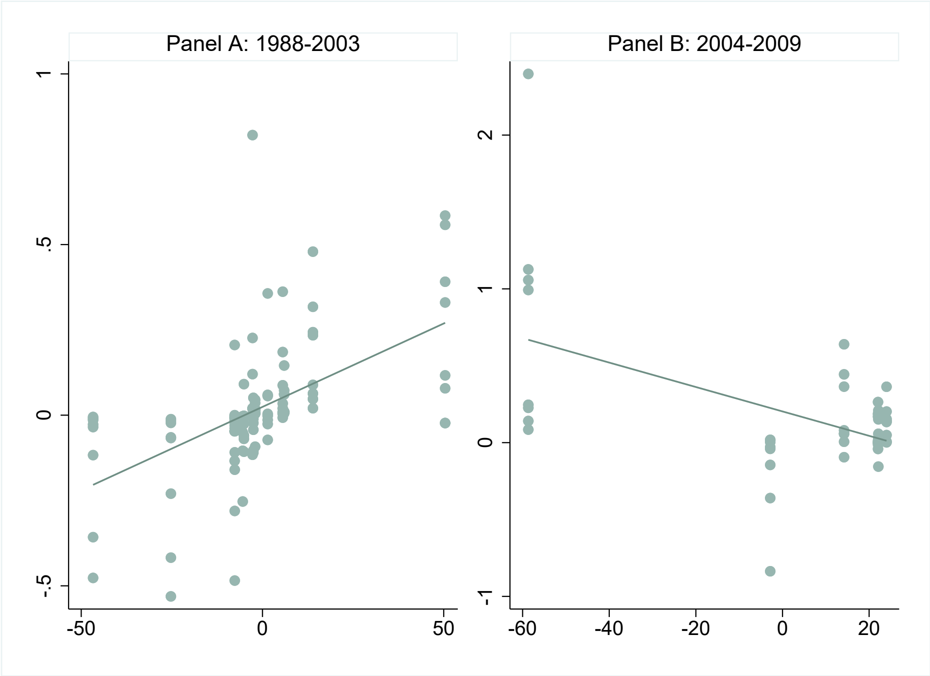
## 7.9 Supplementary material

Table 21: Public consumption and transfers (percent of provincial 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 |

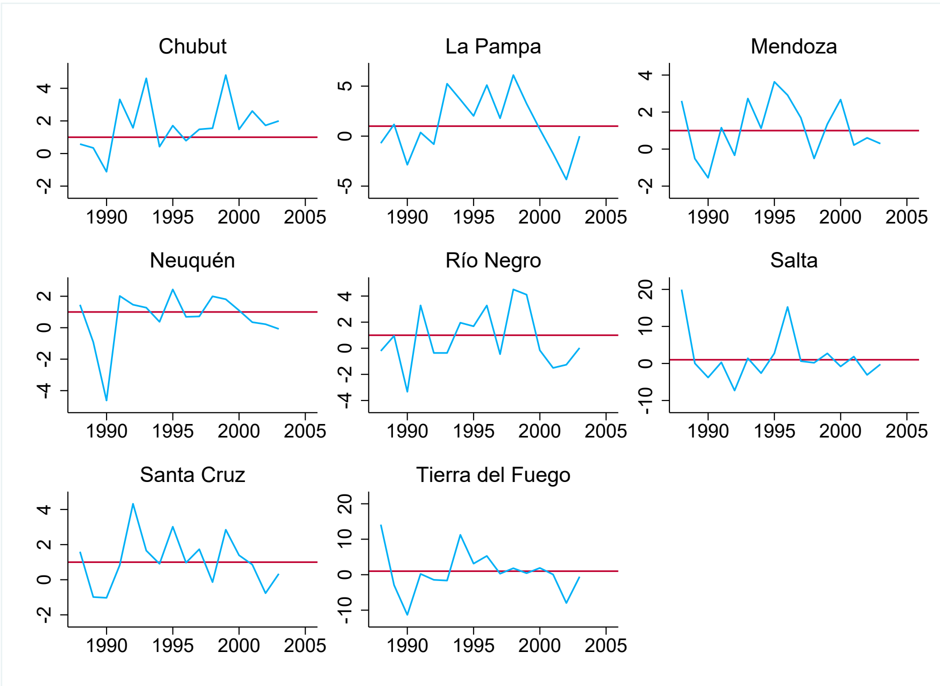
Source: Dirección Nacional de Relaciones Económicas con las Provincias.

Figure 14: Changes in the international oil price and in hydrocarbon royalties




The horizontal axis represents changes in the international oil prince. The vertical axis shows changes in hydrocarbon royalties. Slope of the best fit line in Panel A: 0.001413***. Slope of the best fit line in Panel B: -0.0016186***. In Panel A, we exclude the changes that took place during the hyperinflation in 1989 because they are outliers. Sources: Dirección Nacional de Relaciones Económicas con las Provincias and Instituto Argentino del Petróleo y del Gas.

Figure 15: Provincial reserve replacement rate




The horizontal line indicates a value of the reserve replacement rate equal to one. Sources: *Anuario de Combustibles* and own calculations.

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