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Abstract

Based on the fiscal regime that prevailed in Argentina from 1988 to 2003, we estimate the effects of changes in intergovernmental transfers and hydrocarbon royalties on provincial public consumption and debt. Whenever intergovernmental transfers increase, all provinces primarily increase public consumption and, to a lesser extent, decrease their debt. However, when hydrocarbon-producing provinces experienced an increase in royalties, they saved the entire increase. We provide evidence that the exhaustible nature of royalties may explain this saving reaction in hydrocarbon-producing provinces.

JEL-Codes: C300, H720, H770.

Keywords: intergovernmental transfers, non-renewable resources, hydrocarbon royalties, provincial public consumption and debt, Argentina, Bartik instruments.

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1 Introduction

How do subnational governments react to shocks to their revenue streams? This paper examines this important question, evaluating how Argentine provinces adapted some of their fiscal policies in response to revenue changes between 1988 and 2003.

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

Since 1988, intergovernmental transfers have been regulated by the legal tax-sharing regime called *Coparticipación Federal de Impuestos*. This law stipulated that most of the taxes collected by the national government constituted a common pool, the *Masa Coparticipable*; of this pool, a fraction was retained by the national government, and the remainder had to be shared among all provinces by means of Coparticipation transfers. From 1988 to 2003, Coparticipation transfers represented an average of 94 percent of all intergovernmental transfers in Argentina.

At the same time, revenues originating from hydrocarbon production were mainly determined by international energy prices without any discretionary intervention of the national government, and comprised more than 95 percent of all natural resource royalties in Argentina. However, this high percentage of royalties was concentrated among a small number of provinces that produced hydrocarbons.

These particular features of Argentine fiscal federalism enable us to explore the initial question from two different empirical angles. First, how do provinces react to shocks to Coparticipation transfers, the *common* source of revenue for 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 provincial reactions in public consumption and debt to contemporaneous and lagged changes in Coparticipation transfers and royalties. To address some issues that may invalidate the key assumption that shocks to both sources of revenue were truly exogenous, we adopt a Bartik-like instrumental variables approach.[2] First, we instrument Coparticipation transfers using fixed

[1] In fact, during the period we analyze, provinces had almost no leeway to modify their tax collection when they faced shocks to their other sources of income. Therefore, this paper focuses on intergovernmental transfers and natural resource royalties as the relevant sources of provincial revenue.

[2] A detailed review on Bartik instruments is presented by Goldsmith-Pinkham et al. (2020).

provincial shares interacted with annual changes in the common pool *Masa Coparticipable*. In order to assess whether such an instrument satisfies the exclusion restriction, we follow Goldsmith-Pinkham et al. (2020) and establish that the aforementioned shares were not correlated with many observable provincial socio-economic characteristics in 1988. Second, we instrument royalties employing an index of provincial hydrocarbon abundance in the pre-estimation period interacted with annual changes in the international oil price. We provide evidence that from 1988 to 2003, these changes did not directly affect the economy of hydrocarbon-producing provinces, suggesting that the instrument influenced public policies only through royalties.

When provinces faced an increase in Coparticipation transfers, they mainly increased public consumption and, to a lesser extent, reduced their debt. In particular, the increase in public consumption was assigned to payroll (50 percent), transfers to the public and private sectors (35 percent), and procurement (15 percent). These results are robust to different estimation methods, alternative specifications of the basic regressions, and the inclusion of some controls.

Because only a few provinces earn natural resources royalties, and the majority of this revenue went to only eight provinces, we next proceed to run the same two regressions, but only for hydrocarbon-producing provinces. We confirm that these provinces behaved like the others, spending any increase in Coparticipation transfers solely to raise public consumption. However, when they experienced an increase in royalties, hydrocarbon-producing provinces reacted in the exact opposite direction: they used it entirely to cut down their debt, without modifying public consumption.

We provide two plausible explanations for these sharp differences in fiscal responses among hydrocarbon-producing provinces. First, we observe that the volatility of royalties was higher than the volatility of Coparticipation transfers. Therefore, the decision of these provinces to save a greater percentage of any increase of their most volatile source of revenue could be explained by a precautionary savings argument. Second, we present evidence that these particular provinces were in a mature phase of their hydrocarbon production curve, far from both the initiation of exploitation and depletion. Hence, according to the literature on the optimal use of revenue from nonrenewable natural resources, hydrocarbon-producing provinces were likely to save most of their royalties.

Next, we investigate if there is any evidence in the data pointing 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. However, we found a significant positive relationship between changes in the depletion index and how much these provinces save when they experience increases in royalties. To the very best of our knowledge, this is the first contribution to the local public finance literature that has detected such a relationship, which is consistent with optimal fiscal reactions in mature hydrocarbon-producing jurisdictions that are situated at the increasing part of their production curve.

Related literature. This paper is related to many local public finance contributions that empirically analyze the reactions of subnational governments to changes in their income streams as guided by intertemporal considerations (as in Holtz-Eakin and Rosen 1991 and Dahlberg and Lindström 1998) and paying close attention to the identification strategy (like Knight 2002 and Dahlberg et al. 2008).[3] We build on these contributions by separately estimating expenditure and debt response to contemporaneous and lagged changes in provincial income sources. We instrument these changes by adopting a Bartik-like approach to address their endogeneity. We find statistical evidence that Argentine provincial governments displayed a high and persistent consumption sensitivity to Co-participation transfers.

By including hydrocarbons royalties, our study ties in with a relatively new stream of papers that evaluate the existence of a *resource curse* at the subnational level. Specifically, Caselli and Michaels (2013), Borge et al. (2015), Cassidy (2021), Andersen and Sørensen (2022), Maldonado and Ardanaz (2022), and Martínez (2023), among others, investigate if public revenues originating from the exploitation of natural resources are misused by local authorities and thus induce poor socio-economic, political outcomes. Their approach address the potential problems of omitted variable biases pervasive in previous contributions.[4] Examining provinces within a single country avoids concerns about potentially heterogeneous environments across different countries; basic institutional aspects of political bodies are likely to be less variant (across both sectional units and time) within one country than between multiple countries. In addition, these papers have made an effort to find more exogenous measures of natural resource abundance.[5]

In fact, Cust and Viale (2016) report that the evidence for such poor outcomes in these subnational units is mixed; it is far from being a generalized phenomenon, even in de-

[3]Other contributions to this stream of the literature are Gordon (2004) and Lundqvist (2015).

[4]The natural resource curse hypothesis was initially examined in national cases or empirically studied in multicountry, cross-sectional growth regressions (see van der Ploeg 2011).

[5]For example, Borge et al. (2015) instrumented local revenue from hydropower sources in Norway using indicators of topology, average precipitation, and meters of a river in steep terrain.

veloping countries. Indeed, Borge et al. (2015), Cassidy (2021), Andersen and Sørensen (2022), and Maldonado and Ardanaz (2022) do not find compelling evidence of the subnational resource curse or even report that local policies generate positive results. Our results contribute to the growing skepticism regarding the alleged prevalence of this phenomenon.

From a methodological point of view, the papers closest to ours are Martínez (2023) and Cassidy (2021). These two papers also evaluate fiscal reactions to shocks to different sources of income. Martínez (2023) looks at spending and investment reactions to changes in local taxation and royalties in Colombia. He instruments local taxation using cadastral updates, and he instruments royalties in a similar fashion as we do. Martínez's findings suggest the existence of a subnational resource curse in this country: increases in property tax revenue have a larger impact on the provision of local public services than comparable changes in royalties do, observing that changes in royalties lead to a higher probability that the municipal mayor will face disciplinary prosecution. Cassidy (2021) uses a natural experiment of a permanent adjustment to the general grant transferred by the government of Indonesia to subnational governments. Regarding the provision of public goods, he compares the fiscal response to this permanent change against the response to transitory shifts in oil revenue. 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 are similar in that, at least during the period under analysis, hydrocarbon-producing provinces allocated increases in Coparticipation transfers only towards public consumption, but never did so following increases in royalties.

Finally, although Végh and Vuletin (2015) also deal with intergovernmental fiscal relations in Argentina, our paper differs in many aspects from theirs. Their main goal is to examine whether uncertainty and insurance arguments, and the resulting precautionary savings behavior, can be consistent with a flypaper effect at the provincial level. Accordingly, they merely study expenditure reactions to changes in national transfers and local taxes. On the other hand, we further assess the provincial governments' intertemporal behavior by estimating how public debt changed as a result of shocks to their revenue. Moreover, by including royalties, our paper highlights the specificity of hydrocarbon-producing provinces in Argentina and thus relates our work to the aforementioned subnational resource curse literature. Finally, Végh and Vuletin (2015) consider the 1966-2016 period, which includes various adjustments to the tax-sharing regime. To deal with this issue, they use provincial representation in Congress as an instrument for intergovernmental transfers. By contrast, between 1988 and 2003, a unique legal tax-sharing regime was in place that fixed the secondary distribution coefficients. We use this fact to build a Bartik-type instrument for Coparticipation transfers. This methodological difference may explain why, although qualitatively similar, our results concerning increases in Coparticipation transfers are more nuanced than those found by these authors.

The remainder of the paper is organized as follows. In the next section, we describe provincial public finances in Argentina. In Section 3, we conceptualize our underlying model and 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 revenue in all provinces. Section 5 studies these same fiscal reactions, but only 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 discuss our findings and then conclude in Section 6. In the Appendix, we present additional results. All supplementary materials appear in an Online Appendix.

2 Provincial public finances in Argentina

Argentina is composed of 23 provinces plus the region comprising the capital, Ciudad Autónoma de Buenos Aires (CABA).[6,7] There is significant provincial heterogeneity in Argentina. On the one hand, Buenos Aires, CABA, Córdoba, and Santa Fe account for more than 60 percent of the country's total population and generate almost 75 percent of its gross domestic product (GDP). On the other hand, Catamarca, La Rioja, and Santa Cruz have less than 1 percent of the total population, and Formosa and Santiago del Estero produce less than 0.75 percent of the national output. Per capita gross provincial product (GPP), measured in Argentine pesos (AR$) of 2004, is also unequally distributed, from AR$3,488 in Santiago del Estero to AR$51,619 in CABA, and is negatively correlated with a provincial poverty index.[8]

Provincial public sector. From 1988 to 2003, the provincial public sector amounted to an

[6]Since it is the capital of the country, CABA has some special prerogatives. Nevertheless, concerning all issues analyzed in this paper, this city can be considered a province.

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

[8]Online Appendix OA.1 depicts an administrative map of Argentina and presents provincial statistics.

average of 12.6 percent of the national GDP. This aggregate figure hides great differences among provinces: The percentage of provincial GPP dedicated to the public sector ranges from 3.09 percent (CABA) to 53.42 percent (Formosa).

Expenditure. According to the Argentine constitution, provinces have exclusive and shared responsibilities over social insurance and service provision. Between 1988 and 2003, provincial governments were in charge of an average of 35 percent of consolidated public expenditure.

Although there are important differences in public outlays between provinces (both at absolute and per capita levels), all provinces spend a considerable majority of this expenditure on public consumption (payroll, procurement, and transfers to the public and private sectors). During these years, public consumption represented, on average, 80 percent of public expenditure at the provincial level (see Table J.1 in Appendix J). Therefore, provinces expend a small share of their budget on public investment and thus have a minimal capacity to promote GPP growth. That is one of the main recurrent problems that Argentine provinces have faced for decades, as acknowledged by Porto (2004).

Fiscal revenue

Taxes. For historical reasons, Argentina presents a lower degree of decentralization in revenue than in expenditure. From 1988 to 2003, provinces (and municipalities) raised only 23 percent of the country's tax revenue. Provinces' tax collection amounted to an average of 2.14 percent of their GPP, and these shares were almost constant during that time.[9]

Royalties. Some provinces also receive royalties from natural resources. In particular, this source of income represents a non-negligible fraction of fiscal revenue in Chubut, La Pampa, Mendoza, Neuquén, Río Negro, Salta, Santa Cruz, and Tierra del Fuego. These eight hydrocarbon-producing provinces received, on average, more than 95 percent of all royalties earned in Argentina from 1988 to 2003.

The regime of hydrocarbon royalties was determined by Law 17319, enacted in 1967, which established a procedure to cash them.[10] Under this regime, the national government set a uniform rate of 12 percent of the value of computable oil or gas production, evaluated at domestic prices. Royalties were not redistributed; they were collected by the

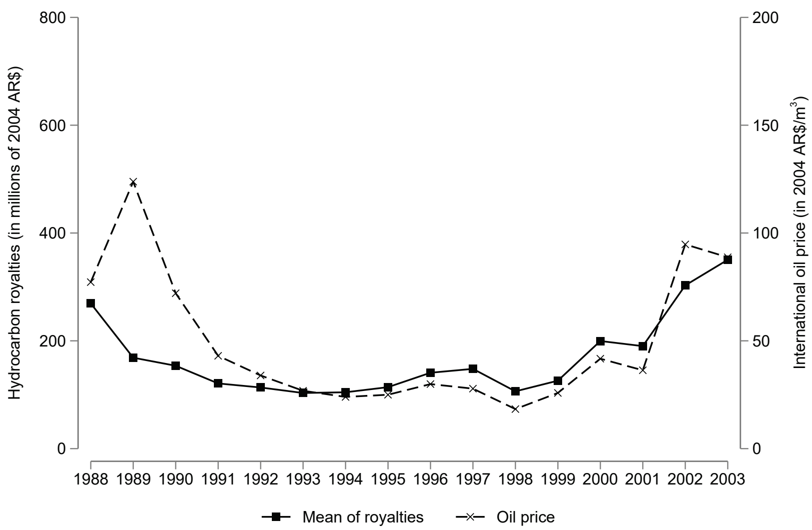
[9] We discuss the historical reasons that explain these fiscal features at the provincial level in Online Appendix OA.2 and present evidence supporting the last assertion in Appendix A.

[10] Online Appendix OA.3 describes the legal regimes that rule royalties from mineral exploitation and hydroelectricity generation.

national government monthly and then returned to the provincial governments where the oil or gas exploitation had originally occurred.

Figure 1 shows the evolution of the average value of royalties per year (across hydrocarbon-producing provinces) and the international oil price between 1988 and 2003. During most of these years, the evolution of royalties closely followed that of the international oil price.[11] Indeed, before 2002, domestic oil and gas prices had been equal to their corresponding international prices because i) no public intervention created a wedge between them and ii) during most of the period, the exchange rate was fixed under *Convertibilidad*, a currency board regime that pegged the Argentine peso to the US dollar.[12]

Figure 1: Hydrocarbon royalties and the international oil price



Sources: *Dirección Nacional de Relaciones Económicas con las Provincias* and *Instituto Argentino del Petróleo y del Gas*.

Other revenue

The gap between provincial expenditure and fiscal revenue generated an important vertical fiscal imbalance, which was solved through a system of intergovernmental trans-

[11]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 Argentina faced hyperinflation and the resignation of President Raúl Alfonsín.

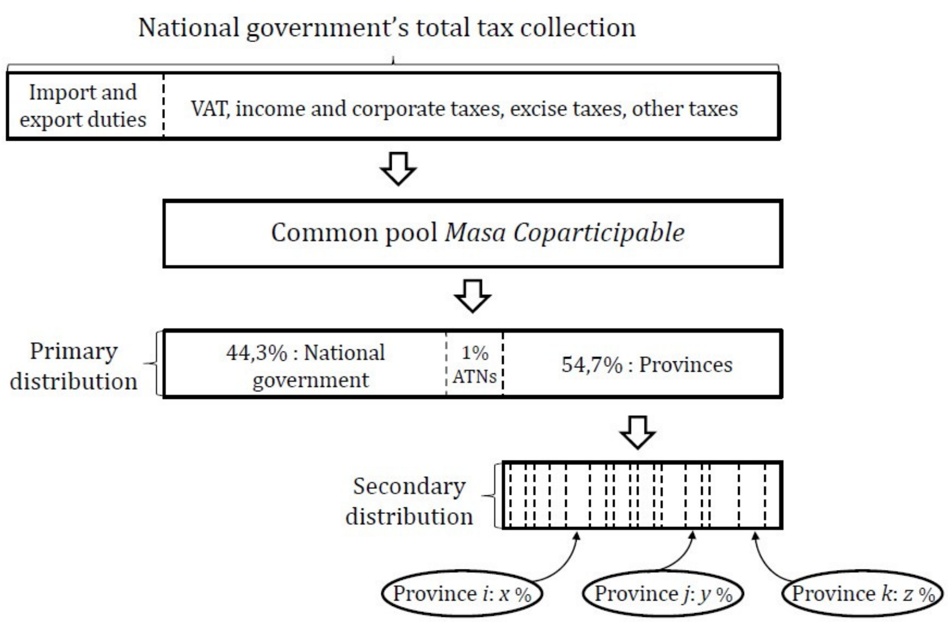
[12]Things changed after the 2001-2002 sovereign-debt crisis, when not only did the government led by President Eduardo Duhalde abandon the currency board, but the state also started to intervene in the energy industry. Therefore, starting in 2003, domestic prices and royalties began to disconnect from international prices, up to a point where the correlation between their changes became negative. See Figure J.1 in Appendix J.

fers and the possibility for provincial governments to issue debt.

Intergovernmental transfers. The system of intergovernmental transfers is based on a tax-sharing regime called *Coparticipación Federal de Impuestos*, regulated by Law 23548 (1988). This law defines how taxes collected by the national government are apportioned among the provinces. This law also states that provinces cannot create new taxes. The peculiarities of this legal framework are explained below, and Figure 2 illustrates its main features.

First, Law 23548 stipulates that most of the taxes collected by the national government form the common pool *Masa Coparticipable*. Then, the common pool's primary distribution is specified: 44.34 percent corresponds to the national government, 54.66 percent goes to all provinces, and the remaining 1 percent makes up a fund called *Fondo de Aportes del Tesoro Nacional*.[13] The law also establishes the secondary distribution: From the part assigned to all provinces, each province should receive a **fixed share** through a pre-established coefficient (see Appendix B). These resources are automatically transferred to the provinces daily, are non-earmarked, and have neither explicit nor implicit matching provisions. Thus, Coparticipation transfers are unconditional, lump-sum grants.

Figure 2: Argentina's tax-sharing regime *Coparticipación Federal de Impuestos*



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

[13]Transfers called *Aportes del Tesoro Nacional* (ATNs) come from this fund, and are distributed at the discretion of the Minister of Interior, to help provinces facing unforeseen contingencies.

From January 1988, when Law 23548 was enacted, until 2003, Coparticipation transfers represented a fairly constant and important share (on average, 94.1 percent) of all intergovernmental transfers (including the discretionary ones) in Argentina.[14]

Debt. Provincial authorities borrowed domestically, issued international public bonds, and received loans from multilateral financial institutions. Although some provinces enacted regulations to restrict debt issuance, these regulations were seldom binding (see Online Appendix OA.5). Therefore, provinces had substantial latitude in dealing with budgetary difficulties using debt, which is what they did. From 1988 to 2003, the consolidated debt of Argentine provinces rose from less than 4 percent to 18.79 percent of the national GDP. These aggregated figures hide an important heterogeneity: The average per capita debt stock in La Rioja was more than 61 times the amount in Córdoba.

3 Empirical analysis

In this section, we provide a framework to empirically investigate how provincial fiscal policies reacted to changes in different sources of income. First, we briefly describe the background that rationalizes our econometric model. Then, we discuss our identification strategy, focusing on the rationale behind the instrumental variables approach we adopted. Finally, we present the data employed.

3.1 Conceptual background

We specify a standard model where provincial governments optimally choose their fiscal policy intertemporally, taking into account various institutional features of subnational public finances in Argentina and how intergovernmental fiscal relations took place between 1988 and 2003. In the following paragraphs, we briefly outline the key elements of that model.

As in Holtz-Eakin et al. (1994) and Dahlberg and Lindström (1998), we consider a representative province,[15] populated by identical residents. At the beginning of each period t, residents receive the private sector output (net of national taxes), Y_t. The provincial government receives Coparticipation transfers TR_t from the national government and

[14] In Online Appendix OA.4, we justify why incorporating subsequent years in our sample is unsuitable for our analysis.

[15] For our posterior empirical analyses, we will then index every province variable with i.

royalties R_t from hydrocarbon production. The provincial government perceives these sources of revenue as random and outside of its control. The provincial government can also tax its residents and issue debt. Following the discussion in Section 2, the tax collection is a small, fixed fraction τ of private sector output Y_t. The provincial government considers Y_t as another exogenously determined random variable. We also assume that the province is a small open economy, with perfect capital mobility. Hence, the provincial interest rate is equal to the (constant) international interest rate r. We denote by D_{t-1} provincial debt issued at date $t-1$, which generates interest payments at date t.

The provincial government chooses current public expenditure, G_t, (we do not consider public investment) and end-of-period debt, D_t, to maximize the expected discounted value of its social welfare function $W(.)$, taking as given the flow of revenue coming from Coparticipation transfers and royalties (plus local taxes). Formally, the problem that solves the provincial government is the following,

$$\max_{\{G_s,D_s\}_{s=t}^{\infty}} \mathbb{E}_t \left[\sum_{s=t}^{\infty} \beta^{s-t} W\left(G_s\right) \right] \tag{1}$$

s.t.

$$G_s + (1+r)D_{s-1} = \tau Y_s + TR_s + R_s + D_s \quad \forall s \geq t, \tag{2}$$

where $\mathbb{E}_t$ denotes expectations computed using the information available at the beginning of period t, β is the social rate of time preference, and (2) characterizes the provincial government's aggregate resource constraint.

From the first order conditions of this problem, we obtain the following equation,

$$G_t^* = \frac{r}{1+r} \left[\mathbb{E}_t \left[\sum_{s=t}^{\infty} \frac{(\tau Y_s + TR_s + R_s)}{(1+r)^{s-t}} \right] + (1+r)D_{s-1} \right], \tag{3}$$

where G_t^*, the optimal level of current public expenditure, is a fraction of total expected wealth (see details of the analytical derivation of the model in Online Appendix OA.6).

In order to obtain closed-form solutions that can be applied for the empirical analysis, we assume for simplicity that the sources of exogenous revenue follow auto-regressive stochastic processes in first differences,

$$\Delta TR_t = \phi(1-\rho_{TR}) + \rho_{TR}\Delta TR_{t-1} + \xi_t, \tag{4}$$

$$\Delta R_t = \mu(1-\rho_R) + \rho_R \Delta R_{t-1} + \epsilon_t, \tag{5}$$

where ϕ, μ, ρ_{TR} and ρ_R are parameters, ζ_t, ϵ_t are white noises, and $\Delta x_t \equiv x_t - x_{t-1}$, $\Delta x_{t-1} \equiv x_{t-1} - x_{t-2}$ denote contemporaneous and one-period lagged changes in the corresponding variable. TR_t and R_t are expressed in first differences because, as usual, these variables are integrated of order 1 (we verified this in our data, see Online Appendix OA.7). Therefore, the first differences will be stationary.

Replacing (4) and (5) in (3) and solving expectations, we derive the following explicit expressions for the contemporaneous change in the optimal level of current public expenditure and debt, respectively

$$\Delta G_t^* = r(1+r)\left[\frac{\phi}{1+r-\rho_{TR}} + \frac{\mu}{1+r-\rho_R}\right] + \frac{1+r}{1+r-\rho_{TR}}\Delta TR_t - \frac{\rho_{TR}(1+r)}{1+r-\rho_{TR}}\Delta TR_{t-1} + \frac{1+r}{1+r-\rho_R}\Delta R_t - \frac{\rho_R(1+r)}{1+r-\rho_R}\Delta R_{t-1} \quad (6)$$

and

$$\Delta D_t^* = -\frac{1+r}{r}\left[\frac{(1-\rho_{TR})\phi}{(1+r-\rho_{TR})} + \frac{(1-\rho_R)\mu}{(1+r-\rho_R)}\right] - \frac{\rho_{TR}}{1+r-\rho_{TR}}\Delta TR_t - \frac{\rho_R}{1+r-\rho_R}\Delta R_t, \quad (7)$$

Conditional on lagged values of Coparticipation transfers and royalties, their contemporaneous changes ΔTR_t and ΔR_t reflect the impact of shocks to these sources of provincial revenue. Thus, the coefficients associated with ΔTR_t and ΔR_t should be interpreted as responses to shocks to Coparticipation transfers and royalties.

Note that the structural equations (6) and (7) have different number of lagged changes in their right-hand side. This difference comes from the analytical derivation of the model. Although the stochastic processes of Coparticipation transfers and royalties are of the same order, current expenditure and debt enter differently in the resource constraint (2).[16] Hence, when taking first-differences, expression (7) only incorporates contemporaneous changes.

The intuition behind these theoretical results is that, as mentioned above, current public expenditure depends on total expected wealth, reflecting a smoothing-type behavior that makes changes in public expenditure a function of contemporaneous and lagged values of revenue shocks. On the other hand, net saving (changes in debt) behaves in a lumpy manner, reacting to contemporaneous changes in revenue.

[16] Only the contemporaneous value of current expenditures, G_s, appears in (2). Additionally, debt also displays its lagged value, D_{s-1}.

3.2 Identification strategy

Based on the structural equations (6) and (7) that describe the optimal response of the provincial government, we propose the following empirical specification,

$$\Delta G_{it} = \psi^G + \alpha_0^G \Delta TR_{it} + \alpha_1^G \Delta TR_{i,t-1} + \beta_0^G \Delta R_{it} + \beta_1^G \Delta R_{i,t-1} + \nu_{it}, \tag{8}$$

$$\Delta D_{it} = \psi^D + \alpha_0^D \Delta TR_{it} + \beta_0^D \Delta R_{it} + \eta_{it}, \tag{9}$$

where i represents a province (24 jurisdictions) and t, a year between 1988 and 2003. We added two error terms, ν_{it} and η_{it}. We estimate (8) and (9) as separate equations. Moreover, standard errors are clustered at the provincial level, to address potential issues of serial correlation (see Bertrand et al. 2004). Because 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 (8) and (9) may raise some concerns. Regarding Coparticipation transfers, 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 2.[17] These legal changes to the Coparticipation regime proceeded from political negotiations between the national government and provincial authorities, thus potentially invalidating the assumption that the new transfers were truly exogenous to provincial spending and debt management. Hence, because the official data on Coparticipation transfers aggregate those initially defined by Law 23548 and the new ones, the variable TR_{it} may be endogenous.

To address this concern, 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 by Law 23548. We thus suggest to use the following Bartik-type instrument for changes in Coparticipation transfers,

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

[17] For example, Buenos Aires received additional revenue from a special fund called *Fondo de Financiamiento de Programas Sociales en el Conurbano Bonaerense*. These resources 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.

where θ_i is the share of the common pool *Masa Coparticipable* that province i should receive, and ΔMC_t is the change in *Masa Coparticipable* in year t. The shares were computed using only the legal secondary distribution coefficients defined in Law 23548.[18]

These legal coefficients were not modified by the national government nor negotiated between provincial representatives in Congress on an annual basis; in fact, they have been legally fixed since 1988 (see Appendix B). Hence, the shares θ_i were also fixed between 1988 and 2003, and thus, political channels like those analyzed by Knight (2002) or Johansson (2003) do not create an endogeneity problem here. Moreover, given that the legal coefficients were not defined by a formula, they do not depend upon observable characteristics, expenditure or any other outcome of provincial policies. This excludes the possibility of reverse causality: 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 θ_i inherit these properties.

In order to justify the exclusion restriction of our instrument W_{it}, we follow Goldsmith-Pinkham et al. (2020) to examine how much the shares θ_i – which by themselves account for a great deal of the key cross-sectional variation in Coparticipation transfers – are correlated with other potential confounds near 1988. In Appendix C, we show that the shares θ_i were not correlated with observable provincial characteristics evaluated near 1988, except with population.[19] On the other hand, the shares θ_i could be potentially correlated with changes in the distribution of Coparticipation transfers introduced after Law 23548 was enacted. This would imply that provinces with higher automatic transfers set according to Law 23548 also benefited more from subsequent transfers, which would represent another potential violation of W_{it}'s exclusion restriction. To verify this situation, in Appendix C we also test whether shares θ_i were correlated with Coparticipation transfers net of their formula-determined amount. We did not find evidence of such a correlation.

The second component of our instrument, ΔMC_t, is completely determined by shifts in the national tax collection, mostly out of the direct control of the provinces. Nevertheless, there could exist transient shocks that, by affecting the GPP of an economically big province, would have an impact on the national GDP and thus – through the amount of taxes collected by the national government – on Coparticipation transfers. At the same time, these shocks could have independent and direct effects on public spending in this particular province, which would induce a potential bias in the estimation. In Appendix

[18] We explain how we obtain the θ_i shares in Online Appendix OA.8

[19] We address this potential threat to identification in Appendix E. Fortunately, we do not observe any effect of this provincial characteristic on our results.

F we address this issue and verify that economically important provinces do not modify our results.

We thus consider W_{it} as a valid instrument for Coparticipation transfers, assuming that the conditional variation of these transfers could be driven by changes in the national tax collection. Specifically, we instrument the lagged change in Coparticipation transfers $\Delta TR_{i,t-1}$ with $W_{i,t-1}$, and the contemporaneous change ΔTR_{it} with W_{it} and $W_{i,t-1}$. The use of additional lagged differences as instruments is motivated by the same rationale utilized in the dynamic panel data literature (e.g., Blundell and Bond 1998; Arellano and Bover 1995), where the use of the first lagged difference as an instrument can be strengthened through the addition of further lags as instruments as well. Besides, as discussed by Hansen et al. (2008), using a larger number of valid instruments has the potential to improve efficiency.

Some issues regarding royalties also have the potential to invalidate our identification strategy. First, we know that, in our data set, the variable R_{it} is subject to measurement errors: Even for hydrocarbon-producing provinces, R_{it} includes royalties coming from mineral resources and hydroelectricity generation.[20] And, as we explain in Online Appendix OA.3, the amount of those other royalties depends on decisions adopted by provincial authorities and thus might not be exogenous to the provincial governments' fiscal policies. Second, even if we focus only on hydrocarbon royalties, we may face a problem of reverse causality because a determinant of hydrocarbon royalties is oil 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.[21] 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 generating social unrest could affect hydrocarbon production (and thus royalties) and provincial expenditure (because provincial authorities increase social programs to appease protesters in such a political situation). This could generate a spurious correlation among these variables.

To address these concerns, we use the following Bartik-type instrumental variable for changes in provincial royalties,

$$Z_{it} \equiv \overline{q}_i \cdot \Delta p_t^*,$$

where $\overline{q}_i$ is the average production of oil between 1985 and 1987 in province i, and Δp_t^* is

[20] Unfortunately, for the period of 1988 to 2003, 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.

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

the change in the international oil price in year t.

The first component of Z_{it} is a predetermined measure of oil abundance. Hence, changes in oil production that occurred after 1988 in one province will not affect the evolution of the instrument, ensuring an exogenous variability in the first stage.

The use of Δp_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 D, we investigate if our instrument was correlated with changes at the provincial level in GPP and unemployment, for all provinces and separately for the eight hydrocarbon-producing ones. We find non-significant results.

Summing up, we believe that Z_{it} can be assumed to be a valid instrument for royalties, implying that the conditional variation of royalties is driven by changes in the international oil price. Therefore, we instrument the lagged change in royalties $\Delta R_{i,t-1}$ with $Z_{i,t-1}$, and the contemporaneous change ΔR_{it} with Z_{it} and $Z_{i,t-1}$.

3.3 Data

We use a data set that covers all Argentine provinces from 1988 to 2003. We subtract 'Interest Payments' from 'Current Public Expenditure' to create the new variable 'Provincial Public Expenditure', denoted by G. This new variable includes payroll, procurement, and transfers to the public and private sectors, but it excludes public investment and interest payments. We also employ disaggregated data on these three items.

Regarding the stock of debt, changes in this variable should be equal to the annual provincial deficit (which includes interest payments and public capital expenditure). Thus, we use 'Financial Result' (deficits after the inclusion of interest payments and public investment) 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 fiscal relations with provincial authorities. Data on Coparticipation transfers and royalties also comes from this department.

We build a time series of the common pool *Masa Coparticipable* by subtracting import and export duties from to the national tax collection. These series 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*, an annual publication from the (former) *Dirección Nacional de Energía y Combustibles*.[22] Oil and gas prices come from the *Instituto Argentino del Petróleo y del Gas*, an NGO that is internationally considered as having the best technical expertise in hydrocarbon industries in Argentina.

Finally, provincial GPP is obtained from Porto (2004) for the period 1987-2000 and from the Ministry of Economy for the period 2001-2003.

We construct the contemporaneous and one-period lagged changes of these variables. We express all money values in thousands of 2004 pesos per capita (unless otherwise stated). Summary statistics for the main variables in the paper are provided in Table 1.

Table 1: Summary statistics

Variable	Mean	Std. Dev.	Max.	Min.	Obs.
ΔG_{it}	-0.001	0.23	1.571	-1.164	360
ΔD_{it}	0.139	0.285	1.46	-0.602	360
ΔTR_{it}	-0.001	0.179	0.636	-1.358	360
$\Delta TR_{i,t-1}$	-0.01	0.181	0.636	-1.358	336
ΔR_{it}	-0.006	0.143	0.821	-1.36	360
$\Delta R_{i,t-1}$	-0.009	0.14	0.585	-1.36	336
ΔY_{it}	0.088	1.687	8.688	-13.107	360
$\Delta Y_{i,t-1}$	0.029	1.72	8.688	-13.107	336
$\overline{q}_i$ (in thousands m^3)	1,065.571	1,949.764	5,943.11	0	24
p_t (in 2004 AR$ per m^3)	49.34	31.68	123.82	18.35	16

4 Fiscal reactions for the full sample of provinces

In this section, we present the fiscal reactions in all provinces. Table 2 provides the first series of estimates, displaying two different specifications of equations (8) and (9).

In Panel (A), we do not instrument provincial revenues. The results show significant positive reactions of public expenditure to the contemporaneous and lagged changes in

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

Table 2: Fiscal responses, all provinces

	(A) Least Squares		(B) 2SLS	
	ΔG_{it}	ΔD_{it}	ΔG_{it}	ΔD_{it}
ΔTR_{it}	0.6592***	-0.0627	0.9823***	-0.3344***
	(0.040)	(0.103)	(0.207)	(0.099)
$\Delta TR_{i,t-1}$	0.3413***		0.3262***	
	(0.064)		(0.073)	
ΔR_{it}	-0.2937	-0.7709***	-0.1250	-1.4005***
	(0.274)	(0.134)	(0.364)	(0.417)
$\Delta R_{i,t-1}$	0.2631***		0.1718	
	(0.093)		(0.463)	
Constant	0.0121**	0.1347***	0.0071	0.1413***
	(0.005)	(0.024)	(0.010)	(0.025)
Anderson-Rubin test			21.87***	22.28***
Number of clusters	24	24	24	24
Observations	336	336	336	336
R^2	0.366	0.158	0.315	0.106

	First stage of Panel (B)			
	(1)	(2)	(3)	(4)
	$\Delta R_{i,t-1}$	$\Delta TR_{i,t-1}$	ΔR_{it}	ΔTR_{it}
Z_{it}			0.0012***	-0.0006
			(0.0005)	(0.001)
W_{it}			0.0364	0.5563***
			(0.029)	(0.044)
$Z_{i,t-1}$	0.0005***	-0.0005	0.0006**	-0.0002***
	(0.0002)	(0.001)	(0.0003)	(0.0001)
$W_{i,t-1}$	0.1407*	0.5971***	0.0293	-0.1711***
	(0.074)	(0.017)	(0.061)	(0.017)
Constant	-0.0062	0.0070	0.0079*	-0.0033
	(0.004)	(0.005)	(0.004)	(0.006)
Kleibergen-Paap Wald statistic	4.98		4.97	
Number of clusters	24		24	
Observations	336	336	336	336
R^2	0.076	0.577	0.361	0.611

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

Coparticipation transfers. However, provincial reactions to changes in royalties are different. Facing a contemporaneous increase in this source of revenue, provinces do not modify their public expenditure; instead, they decrease their deficit in a statistically significant way.

Panel (B) presents the coefficients derived from our chosen specification, where we instrument Coparticipation transfers and royalties, and we estimate equations (8) and (9) with 2SLS.

The bottom part of Table 2 presents the first-stage estimation for contemporaneous and lagged changes in Coparticipation transfers and royalties. For each source of revenue, the estimated coefficient of its corresponding instrument is positive (as predicted) and statistically significant. Remember that standard errors are clustered. Since we are in a heteroskedastic case, the usual F tests for weak instruments do not apply (see Montiel Olea and Pflueger, 2013). Although to the best of our knowledge there is no test for weak instruments in the heteroskedastic case with multiple endogenous regressors, Andrews et al. (2019) suggest to use the Kleibergen-Paap Wald statistic in exactly identified models like ours. The $p-$values of that test (0.13 and 0.21, respectively) seem to provide marginal statistical evidence of a potential problem of weak instruments. Nevertheless, it is still possible to perform valid inferences even with such instruments, as the results of the Anderson-Rubin tests reported at the top of Table 2 suggest.[23] These results provide statistical support to reject the null hypothesis that all structural coefficients are simultaneously zero.[24]

In the second-stage regression in Panel (B), we obtain a statistically and economically significant positive estimated response of public expenditure, and a negative, but less economically 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 expenditure by nearly 98 cents and decrease debt by 33 cents.[25] 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 Holtz-Eakin et al. (1994) but lower than those reported by Végh and Vuletin (2015).

Regarding the reactions to changes in royalties, the coefficient for public expenditure is not statistically significant. However, public debt reacts negatively – and in a statistically significant way – to an increase in this source of revenue.[26] Recall that many provinces have never received revenue from royalties. Therefore, this coefficient implies two under-

[23] As Andrews et al. (2019) discuss, Anderson-Rubin confidence sets are robust to weak identification and are efficient in the exactly-identified case, providing a strong argument for using these procedures in exactly-identified settings.

[24] In other words, when the Anderson-Rubin test rejects the null that all structural coefficients are simultaneously zero, then the variables we have instrumented have a *joint* statistically significant effect on the dependent variable.

[25] We acknowledge that these estimated coefficients are high, and their sum is slightly larger than one. However, recall that our regressions do not take into account all sources of public income; in particular, provincial tax revenues are not included. Please note that when we control for them in Appendix G, this aggregated effect is softened.

[26] Although the estimated coefficient (-1.4005) seems high, its 95 percent confidence interval is $[-2.218; -0.582]$. Thus, we cannot reject that is is statistically different from -1.

lying effects: first, the effect of being or becoming an hydrocarbon-producing province, and, second, the effect of a unit change in royalties for the former. The coefficient thus displays the overall effect of a contemporaneous shock to royalties on public debt in any province, in situations in which an increase in royalties encouraged provincial governments to reduce their deficit.

Shocks in Coparticipation transfers have persistent impacts on provincial policies: they affect current expenditure contemporaneously, as well as one year ahead. Overall, these results suggest that shocks to royalties lead to less expenditure than shocks to Coparticipation transfers do, both contemporaneously and in the medium term.

Finally, Table 3 helps us examine the effect of provincial revenues on a further disaggregation of public consumption. For each peso of increase in Coparticipation transfers, provinces react by increasing payroll (48 cents), procurement (15 cents), and transfers to the public and private sectors (35 cents). The effect of Coparticipation transfers on personnel spending and transfers to the public and private sectors is persistent over time, since the coefficient of its lag is positive and statistically significant. However, all reactions to changes in royalties do not appear to be statistically significant.

Table 3: Effects on disaggregated government spending, all provinces

	(1) Payroll	(2) Procurement	(3) Transfers to the public and private sectors
ΔTR_{it}	0.4814***	0.1469***	0.3541***
	(0.094)	(0.029)	(0.096)
$\Delta TR_{i,t-1}$	0.2446***	-0.0432	0.1248*
	(0.083)	(0.044)	(0.066)
ΔR_{it}	-0.2876	0.0154	0.1471
	(0.271)	(0.073)	(0.090)
$\Delta R_{i,t-1}$	0.1306	0.2068	-0.1655
	(0.371)	(0.251)	(0.264)
Constant	0.0004	0.0073**	-0.0006
	(0.005)	(0.003)	(0.007)
Observations	336	336	336
R^2	0.261	0.116	0.208

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

We have also explored in the appendices the robustness of our results in different ways. In Appendix G, first, we estimated Panel (B) using other estimation methods, which allows us to relax the assumptions that the error terms ν_{it} and η_{it} were (a) independent from one another; and (b) normally distributed, which may be inefficient in this setting where changes in public expenditure and debt are simultaneously chosen by provincial governments. To address these concerns, we estimated (8) and (9) via two alternative estimation methods: we used 3SLS to estimate both equations as a system, and we followed a distribution-free approach using GMM (see panels (J) and (K) of Table G.1, respectively).

Second, to avoid omitted variable biases, we add in the regression the GPP net of local tax collection, ΔY^n_{it} and $\Delta Y^n_{i,t-1}$, respectively, to control for shocks to provincial tax bases (see Panel (L) of Table G.1).

Third, we test the sensitivity of our results under different dynamic specifications, adding and excluding different lags of our explanatory variables (see panels (M) and (N) of Table G.1).

Finally, in Online Appendix OA.9, we report the results of the regressions when we drop from the sample three particular provinces (Santiago del Estero, La Rioja, and Buenos Aires), one by one, to see whether our regressions change in any meaningful way. During the period under analysis, these provinces presented atypical increases in different provincial revenues, which might bias our estimations.

None of those new specifications had a qualitative impact on the results as presented in Panel (B) in Table 2. We thus 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 have instrumented royalties, one might still suspect that the estimated reactions to their changes in Table 2 could be inconsistent. Indeed, the estimated coefficients capture the average response of all provinces in a situation where only a few of them receive this type of funds. Moreover, as postulated by the literature on the natural resource curse at the subnational level, we can also argue that provinces receiving hydrocarbon royalties may be different from other jurisdictions in terms of their economic, social, or institutional characteristics, which could imply that the reactions of their public expenditure and debt also differ for Coparticipation transfers. To evaluate these hypotheses, in Table 4 we estimate equations (8) and (9) using 2SLS, but for hydrocarbon-producing provinces only.

As expected, given the design of the royalties' instruments Z_{it} and $Z_{i,t-1}$, in the first stage the Kleibergen-Paap Wald statistics increase with respect to their values obtained in Table 2, from 4.98 to 6.162 and from 4.97 to 14.765, respectively. These new statistics display $p-$values of 0.11 and 0.01, respectively. This suggests that the possibility of facing a weak instrument problem seems to have been reduced. Then, the Anderson-Rubin test appears to statistically support the validity of the inference of the second stage.

Regarding the second stage, hydrocarbon-producing provinces spend in full on public consumption any contemporaneous increase in Coparticipation transfers.[27] Moreover, such shocks have persistent effects on public consumption one period ahead.[28]

Furthermore, Table 5 details these provinces' public consumption reaction at a more disaggregated level. When hydrocarbon-producing provinces experienced an increase in Coparticipation transfers, said provinces spent these additional transfers in a similar manner (in percent) to what other provinces did, with the same persistence in payroll.[29] However, debt management does not react to changes in Coparticipation transfers in these eight provinces. Hence, when they faced shocks to the source of revenue that is common to all provinces, hydrocarbon-producing provinces behaved like the others did, in terms of public expenditure.

But these eight provinces reacted differently – qualitatively and quantitatively – to shocks to their specific source of revenue: When their royalties increased by one peso, they channeled the adjustment towards a large decrease in their deficit, rather than modifying public consumption.[30]

Our results suggest that hydrocarbon-producing provinces spent any increase in Coparticipation transfers, while they saved increases in royalties.[31] In the next section, we provide two alternative explanations for why these provinces might have behaved in this way, and we analyze the plausibility of these explanations. Finally, we try to find in the data any evidence of the mechanisms mentioned in these explanations.

[27] Although the estimated coefficient (1.476) seems high, its 95 percent confidence interval is $[0.83; 2.122]$. Thus, we cannot reject that it is statistically different from 1.

[28] In Online Appendix OA.10 we present supplementary evidence that these hydrocarbon-producing provinces' reactions are similar to those of other provinces.

[29] There are only two differences between these results and those of Table 3: (a) the effect on transfers to the public and private sectors of an increase in the change in royalties is now positive and significant at the 5 percent level, and (b) while similar in magnitude, the effect on transfers to the public and private sectors of an increase in the one-period lagged change in Coparticipation transfers loses its statistical significance.

[30] The 95 percent confidence interval of the estimated coefficient (-1.19) is $[-1.74; -0.645]$.

[31] In Online Appendix OA.11, we present narrative evidence supporting this last assertion.

Table 4: Fiscal responses, hydrocarbon-producing provinces

	2SLS	
	(C)	
	ΔG_{jt}	ΔD_{jt}
ΔTR_{jt}	1.4760***	-0.1358
	(0.330)	(0.149)
$\Delta TR_{j,t-1}$	0.3286**	
	(0.145)	
ΔR_{jt}	0.2240	-1.1909***
	(0.348)	(0.279)
$\Delta R_{j,t-1}$	0.1827	
	(0.397)	
Constant	-0.0039	0.2120***
	(0.033)	(0.047)
Anderson-Rubin test	149.76***	23.91***
Number of clusters	8	8
Observations	112	112
R^2	0.401	0.128

	First stage of Panel (C)			
	(1)	(2)	(3)	(4)
	$\Delta R_{j,t-1}$	$\Delta TR_{j,t-1}$	ΔR_{jt}	ΔTR_{jt}
Z_{jt}			0.0012***	-0.0006**
			(0.0004)	(0.0003)
W_{jt}			0.0753	0.4929***
			(0.070)	(0.084)
$Z_{j,t-1}$	0.0006***	-0.0005*	0.0006**	-0.0003***
	(0.0002)	(0.0003)	(0.0006)	(0.0001)
$W_{j,t-1}$	0.2796***	0.6160***	0.0651	-0.1605***
	(0.092)	(0.033)	(0.146)	(0.037)
Constant	-0.0189	0.0164	0.0239**	0.0065
	(0.012)	(0.013)	(0.011)	(0.014)
Kleibergen-Paap Wald statistic	6.162		14.765	
Number of clusters	8	8	8	8
Observations	112	112	112	112
R^2	0.122	0.524	0.378	0.484

Notes: 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.

Table 5: Effect on disaggregated government spending, hydrocarbon-producing provinces

	(1) Payroll	(2) Procurement	(3) Transfers to the public and private sectors
ΔTR_{jt}	0.6429***	0.2480***	0.5851***
	(0.171)	(0.032)	(0.147)
$\Delta TR_{j,t-1}$	0.2817***	-0.0725	0.1194
	(0.066)	(0.055)	(0.127)
ΔR_{jt}	-0.1873	0.0950	0.3163**
	(0.212)	(0.085)	(0.137)
$\Delta R_{j,t-1}$	0.2275	0.1323	-0.1770
	(0.210)	(0.131)	(0.255)
Constant	-0.0037	0.0126**	-0.0129
	(0.015)	(0.006)	(0.022)
Observations	112	112	112
R^2	0.358	0.172	0.307

Notes: 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.

5.1 Plausible explanations for the observed saving reactions

5.1.1 Volatility of different sources of public revenue

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, ceteris paribus. If this was indeed the case, then a precautionary savings argument, as pointed out by Végh and Vuletin (2015), could be made to explain these different reactions.[32]

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 H, we perform this analysis in two different ways. First, we corroborate that, in each hydrocarbon-producing province, 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 that

[32] As already mentioned, Cassidy (2021) 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.

of Coparticipation transfers. Therefore, in Argentina, royalties were more volatile than Coparticipation transfers were during the period from 1988 to 2003, 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 on any increase in royalties could be intergenerational considerations and concerns over hydrocarbons being nonrenewable resources. In an intertemporal model with price and geological uncertainty, Barnett and Ossowski (2003) explain 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. This hypothesis, which is reminiscent of the tax smoothing literature (Barro 1979), indicates that governments must issue public debt at the initiation of exploitation, while at a more mature stage of production (but still far from depletion) they should save their royalties. A similar prediction results from models that analyze the cases of resource-rich developing economies. van der Ploeg and Venables (2011) discuss this issue within a model that includes other policy options, such as private capital accumulation and public infrastructure construction. In general, they argue that the optimal use of an increase in government revenue from natural resource production is not to raise public consumption. Instead, during a mature stage of production, governments should save the increases of their royalties. In the following paragraphs, we show that hydrocarbon-producing provinces in Argentina were indeed at a mature stage of production.

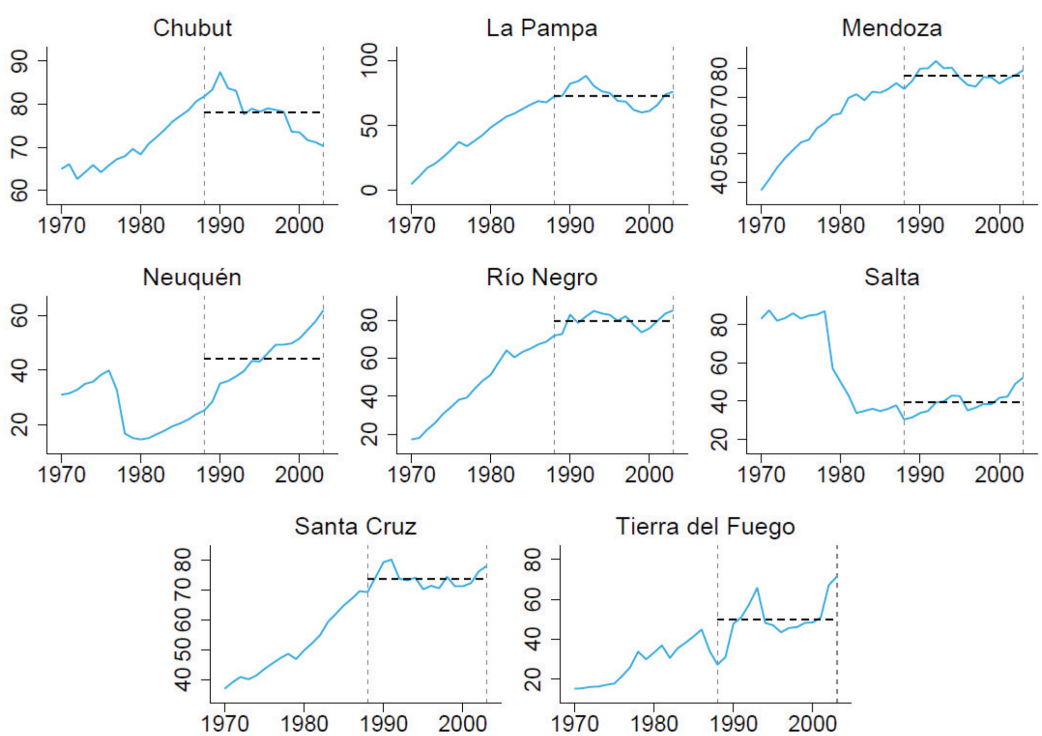
First, the period from 1988 to 2003 does not correspond to the early stages of Argentina's oil and gas production, as shown in Figure J.2 in Appendix J, where we plot the provinces' historical production of hydrocarbons. Clearly, none of these eight provinces was at an initial stage of production in 1988.

However, is it then possible that these particular provinces were nearing hydrocarbon depletion between 1988 and 2003, when, according to the aforementioned contributions, their public consumption should have been supported by interests earned on accumulated assets? We establish that this too was not the case by constructing a depletion index for the years 1970-2003. Each hydrocarbon-producing province j is slotted into the index

$$DI_{jt} \equiv \frac{\sum_{s=0}^{t} q_{js}}{\sum_{s=0}^{t} q_{js} + Res_{jt}},$$

which is the ratio (measured in percentage) of accumulated hydrocarbon production (from the beginning of exploitation up to year t) to the expected total amount of economically recoverable resources contained in all provincial reservoirs. This denominator is proxied by the total of accumulated production up to t, $\sum_{s=0}^{t} q_{js}$, plus proved reserves at t, Res_{jt}. Figure 3 shows the depletion index DI_{jt} for the full range of years and the average between 1988 and 2003.[33]

Figure 3: Index of hydrocarbon depletion, by province



Notes: The depletion index is measured in percent. The dotted line represents the average value of DI_{jt}.
Sources: *Anuario de Combustibles* and own calculations.

[33]Because this figure illustrates an index built using long term data, we present it across a longer period of time to assess its value in perspective. However, we could not go further back in time because there is no available data for oil and gas reserves in Argentina prior to 1970.

Between 1988 and 2003, the depletion index for Neuquén, Salta, and Tierra del Fuego was, on average, below 50 percent. From this, we can definitely assert that these three provinces were far from exhausting their hydrocarbon resources. 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, similarly high values are common to countries or regions that have been producing for a long time (because aggregate historic production weighs significantly on the depletion index). This potential explanation for the depletion index values is not sufficient to determine that these five provinces were not close to depletion. To confirm their actual status, in Appendix I we analyze the evolution of their hydrocarbon production during the period under analysis. We confirm that, on average, more hydrocarbon reserves were discovered than extracted in these five provinces between 1988 and 2003. Therefore, Chubut, La Pampa, Mendoza, Río Negro, and Santa Cruz were not at the final stage of hydrocarbon production either.

We conclude that during 1988-2003, hydrocarbon-producing provinces were at a mature stage of production – that is, far from both the initiation of exploitation and from depletion. Therefore, according to the literature that studies the optimal use of revenue from a non-renewable source, the optimal choice for these provinces might have been to save their royalties.

5.2 Evidence of these explanations in our data

Having identified two potential mechanisms that could explain our results, we try to find suggestive evidence of whether any of these mechanisms are operating in our data. To do that, we incorporate into the second stage of Table 4 variables that are related to these mechanisms.

We were not able to detect any effect of the different volatilities of either revenue source on the fiscal reactions of hydrocarbon-producing provinces.[34] However, things are different concerning the second mechanism. We consider **changes** in the depletion index, $\Delta DI_{jt} = DI_{jt} - DI_{j,t-1}$, to be the most relevant variable to relate the non-renewable nature of royalties to observed provincial fiscal behavior in a parsimonious way. Indeed, we find that ΔDI_{jt} has a substantial impact on how these provinces react to shocks to this revenue source. Table 6 presents the results.

[34]We present these results in Online Appendix OA.13.

Although ΔDI_{jt} has no direct effect on provincial policies, the estimated coefficients of the interaction $\Delta DI_{jt} \cdot \Delta R_{jt}$ are negative and significant in both regressions in Panel (E).[35] The total effect of a one-peso increase in royalties on ΔG_{jt} is $(0.5097) + (-0.2127) = 0.297$, with a p-value of 0.458. However, this same effect on ΔD_{jt} is significant: it amounts to $(-0.799) + (-0.336) = -1.135$, with a p-value of 0.003.

Table 6: Depletion and fiscal responses in hydrocarbon-producing provinces

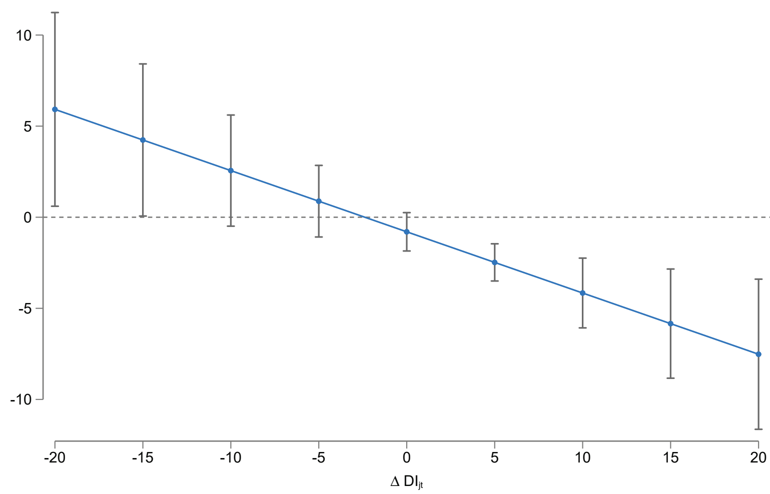
	(D)		(E)	
	ΔG_{jt}	ΔD_{jt}	ΔG_{jt}	ΔD_{jt}
ΔTR_{jt}	1.2847***	-0.1991	1.3992***	-0.0757
	(0.301)	(0.179)	(0.387)	(0.242)
$\Delta TR_{j,t-1}$	0.3292**		0.5207***	
	(0.137)		(0.198)	
ΔR_{jt}	0.1026	-1.2417***	0.5097	-0.7990*
	(0.328)	(0.305)	(0.415)	(0.455)
$\Delta R_{j,t-1}$	0.2596		-0.2438	
	(0.390)		(0.301)	
ΔDI_{jt}	-0.0042	-0.0028	-0.0053	-0.0091
	(0.003)	(0.008)	(0.004)	(0.006)
$\Delta DI_{jt} \cdot \Delta R_{it}$			-0.2127***	-0.3360***
			(0.076)	(0.116)
Constant	0.0190	0.1965***	0.0171	0.2004***
	(0.030)	(0.049)	(0.040)	(0.047)
Observations	112	112	112	112
R^2	0.403	0.124	0.440	0.223

Notes: 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 4 illustrates, for given values of ΔDI, the average marginal impact of royalties on the debt reaction, with its corresponding 95 percent confidence interval.

[35] There may be an additional potential concern for endogeneity in these regressions: The second component of the royalties' instrument Δp_t^* may be correlated with ΔDI_{jt}. In Online Appendix OA.14, we show that such a correlation did not exist between 1988 and 2003.

Figure 4: Average marginal effects of royalties



For example, if $\Delta DI = 1$ percentage point, a hydrocarbon-producing province that is approaching depletion reacts to a one-peso increase in royalties by decreasing debt by $(-0.799) + 1 \cdot (-0.336) = -1.135$ pesos. Even though this value seems high, its confidence interval includes 0. For bigger increases in the depletion index, the debt reductions are statistically significant.[36] Therefore, Figure 4 confirms that the closer a province gets to depletion (i.e., the higher the value of ΔDI), the greater the saving reaction of hydrocarbon-producing provinces when they experience 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 it is consistent with optimal fiscal reactions in mature hydrocarbon producing jurisdictions that are situated at the increasing part of their production curve (see Figure J.2 in Appendix J).

6 Conclusions

Studying the impact of changes in public revenue 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 as the outcome of provincial policies. In other cases, these transferred

[36] We also observe a significant average increase in debt when the depletion index decreases by more than 15 percentage points.

funds are discretionarily assigned by annual budget decisions that reflect political negotiations among Congress representatives or directly between national and subnational authorities.

This paper addresses these issues by focusing on the debt and spending behavior of Argentine provinces. Most transfers that provinces received from the national government came from the Coparticipation tax-sharing regime. In addition, we also examine hydrocarbon royalties, a main source of income for eight Argentine provinces. We consider the years of 1988-2003, when regulations regarding the tax-sharing regime and royalties were persistently enforced. Unlike Coparticipation transfers, royalties 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 annual changes to the common pool of taxes collected by the national government. We also instrument royalties, with an index of provincial hydrocarbon abundance in the pre-estimation period interacted with annual changes in the international oil price.

On average, provinces used almost all increases in their Coparticipation transfers to expand public consumption, reserving only a minor amount to reduce their debt. In addition, hydrocarbon-producing provinces fully employ any increase in royalties to lower their debt. These results are robust to different specifications of the basic regressions we run.

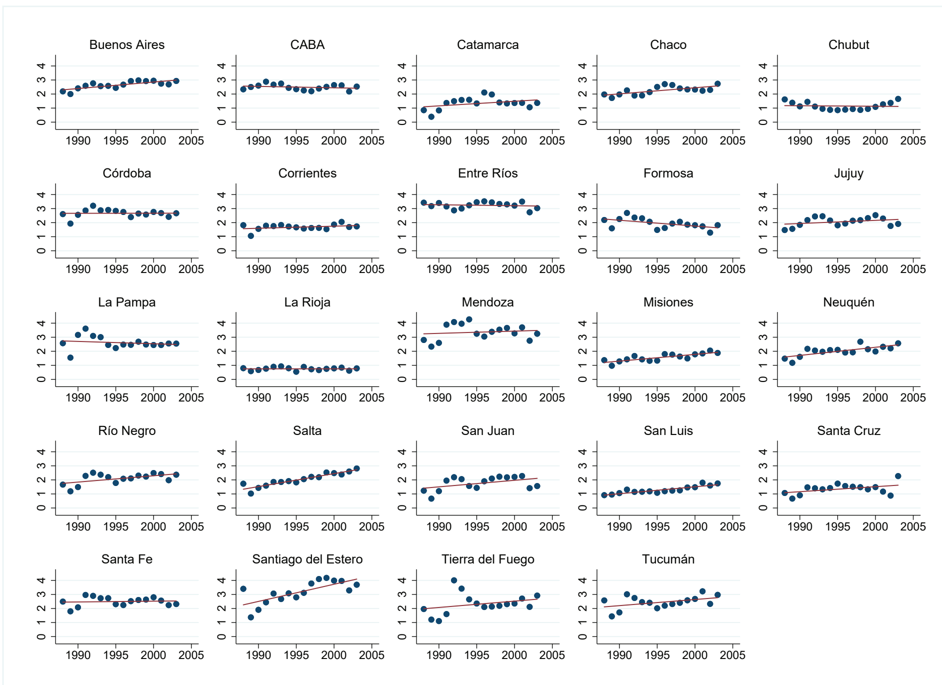
To potentially explain why hydrocarbon-producing provinces save more of their royalties than of Coparticipation transfers, we emphasize the higher volatility of royalties and the exhaustible nature of these revenues. Although we could not detect any evidence of the former mechanism in our data, we find a positive relationship between changes in the hydrocarbon depletion index and provincial savings. Our results contribute to the growing skepticism regarding the alleged prevalence of the subnational resource curse.

Appendix

A Provincial tax collection between 1988 and 2003

As Figure A.1 shows, the shares of provincial tax collection over GPP were rather constant during this time. For all provinces, the best-fit line of their annual share presents no statistically significant slope or, when it is statistically significant, its economic significance is negligible.[37]

Figure A.1: Provincial tax collection (as percent of GPP)



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

B Legal coefficients of the *Masa Coparticipable* 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 subsequent evolution. Law 20221, the first to uniformly regulate the Argentine tax-sharing regime, was enacted in 1973. This law had a stipulated duration of 10 years

[37] In Online Appendix OA.9 we analyze the particular case of Santiago del Estero because this province's tax receipts increased more between 1988 and 2003 than any other province's did.

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.[38]

Although a new Coparticipation law should have been passed in 1983, the newly 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, during the period between 1985 and 1987, intergovernmental transfers did not follow automatic and transparent procedures. Instead, the allocation of funds was done *'according to ad hoc negotiations in which political factors predominated (...) According to the dynamic of these years, Alfonsín and his Economy Ministers negotiated the size and timing of revenue transfers directly with the governors'* (Eaton (2004)). At the beginning of this period of legal vacuum, the pattern of these transfers across provinces was similar to what could be observed under Law 20221. However, after the Peronist opposition won the 1987 legislative elections, the negotiations between President Alfonsin and the governors started to reflect the new distribution of political power, and the pattern of transfers changed.

When Congress finally enacted Law 23548 in January 1988, the legal coefficients set in its Article 4 were the following:

Table B.1: 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		

These coefficients replicated the shares of all transfers that each province had been receiving, on average, during the previous months.

The primary reason for why these coefficients have remained constant since 1988 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 an absolute majority of each congressional house, and

[38]To illustrate this point, the development gap index was built using, as explanatory variables, housing quality, cars per inhabitant, and degree of education.

then iii) has to be approved by all provincial legislatures. Therefore, unsurprisingly, even though the 1994 constitutional amendment mandated Congress to approve a new Coparticipation law by 1996, Law 23548 continues to rule the Argentine tax sharing regime even now.

C Correlations between provincial shares θ_i and socioeconomic indicators in 1988

As a plausible justification for the exclusion restriction of our instrument W_{it}, we examine the amount of correlation present between the shares θ_i and other potential confounds near 1988. We consider the following socioeconomic provincial indicators: poverty index, population, density, per capita GPP, size of the public sector (in terms of total expenditure as percent of GPP), and share of Coparticipation transfers to total provincial revenue. Some of these indicators were employed in setting Coparticipation transfers under the previous Law 20221 (1973) (See Appendix B), and others are currently used in the local public finance literature to explain intergovernmental grants. Table C.1 exhibits the results.

Table C.1: Correlations between the shares θ_i and provincial indicators

	Pearson corr. coef.	p-value
Poverty index (1987)	-0.216	0.310
Population (1987)	0.947	2.66×10^{-12}
Density (1987)	-0.092	0.677
GPP/hab (1988)	-0.205	0.335
Size Pub. Sector (1988)	-0.235	0.269
Cop. tr./Total revenues (1988)	-0.250	0.239

The correlations between the shares θ_i and the poverty index, density, per capita GPP, size of the public sector, and the share of Coparticipation transfers to total provincial revenue were all statistically insignificant. We do find a positive and significant correlation with population, which is expected as a remnant from previous tax-sharing regimes. These results may imply a potential concern about endogeneity, which we address and discuss in Appendix E.

In the following table, we test whether Coparticipation transfers TR net of their formula-determined amount, TR^*, have a significant correlation with the shares θ_i.

Table C.2: Coparticipation transfers net of their formula-determined amount and shares θ_i

	$TR - TR^*$
θ_i	3.0168
	(4.084)
Constant	-0.3769***
	(0.118)
Observations	360
R^2	0.048

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

We observe no correlation between these items, which suggests that provinces with higher shares θ_i do not seem to have benefited from obtaining higher transfers compared to what was set in Law 23548.

D The instrument Z_{it} and provincial economic indicators

To satisfy the exclusion restriction, the instrument Z_{it} must affect provincial public expenditure and debt only through royalties.

In the following table, we test whether, during the period under analysis, our instrument was correlated with contemporaneous changes in two economic indicators at the provincial level: per capita GPP and unemployment.[39] In Table D.1, Panel (F) displays the results for all provinces, and Panel (G) only those for hydrocarbon-producing ones.

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

Table D.1: Instrument and changes in economic indicators

	(F) All provinces		(G) Hydrocarbon-producing provinces	
	GPP	Unemployment	GPP	Unemployment
Z_{it}	-0.001	0.005	-0.001	0.005
	(0.001)	(0.004)	(0.001)	(0.003)
Constant	0.089	0.413***	-0.064	0.370***
	(0.120)	(0.058)	(0.308)	(0.086)
Observations	360	345	120	105
R^2	0.002	0.011	0.003	0.048

Notes: Data on provincial unemployment retrieved from the *Observatorio de Empleo y Dinámica Industrial* of the Ministry of Labor, Employment and Social Security. Least squares 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 changes in these economic indicators, either in all provinces or in hydrocarbon-producing ones. These results do not seem to validate the presumption that a peak in the international oil price boosts local economic activity.

E Supplementary evidence in favor of the validity of the exclusion restriction of Coparticipation transfers's instrument W_{it}

We have provided evidence that the shares θ_i were positively correlated with population in 1987. This provincial characteristic might affect not only the level of Coparticipation transfers but also expenditure and debt decisions, which would put into question our identification strategy. To deal with this potential violation of the exclusion restriction of the instrument W_{it}, we proceed to estimate the model grouping provinces with similar populations together in order to control for this characteristic in the basic regressions. Specifically, we consider provinces that had population over 1 million inhabitants in 1987,[40] and we add the interaction effect of the dummy defined as

[40]These highly populated provinces are Buenos Aires, CABA, Córdoba, Entre Ríos, Mendoza, Santa Fe, Salta, and Tucumán.

$$\mathbb{1}_i = \begin{cases} 1 & \text{if province } i \text{ had a population larger than one million in 1987,} \\ 0 & \text{otherwise.} \end{cases}$$

In Table E.1, we present the results. Since the threat of identification that we want to address solely concerns the instrument of Coparticipation transfers, we only analyze changes in this source of income. Note that the coefficients of all interaction effects are individually insignificant. However, some of them are as large as or larger than the coefficient of the main variable, which could suggest that their insignificance likely stems from the small sample size. Additionally, in the bottom part of the table, we show the sum of the estimated coefficients of the main variables and their interaction, and we then compute their 95 percent confidence interval. Therefore, in all cases, these intervals contain the corresponding coefficient of the main variable.[41] Hence, we don't find significant evidence that the reactions to changes in Coparticipation transfers differ between the highly populated provinces and the others, suggesting that the aforementioned positive correlation is not a threat to our identification strategy.[42]

[41] Note that this exercise of comparing the coefficient of the main variable with a confidence interval of the coefficient of the main variable plus the coefficient of its respective interaction term is mathematically equivalent to testing the individual significance of the coefficient of the interaction against zero.

[42] In the second regression, the dummy is statistically significant, suggesting that, on average, highly populated provinces have lower increases in debt than the others. This group includes the six provinces whose GPP make up the largest share of the national GDP. The fact that these economically big provinces have more financial capacity to manage their public debt could explain the differences we found.

Table E.1: Interactions with highly populated provinces

	(1) ΔG_{it}	(2) ΔD_{it}
ΔTR_{it}	0.9830***	-0.3312**
	(0.179)	(0.146)
$\mathbb{1}_i * \Delta TR_{it}$	0.0045	-0.1248
	(0.208)	(0.206)
$\Delta TR_{i,t-1}$	0.3243	
	(0.321)	
$\mathbb{1}_i * \Delta TR_{i,t-1}$	0.1242	
	(0.370)	
ΔR_{it}	-0.1951	-1.8591*
	(1.637)	(1.115)
$\mathbb{1}_i * \Delta R_{it}$	0.2698	1.7408
	(1.800)	(2.030)
$\Delta R_{i,t-1}$	0.1266	
	(1.447)	
$\mathbb{1}_i * \Delta R_{i,t-1}$	0.3294	
	(1.619)	
Constant	0.0076	0.1763***
	(0.020)	(0.031)
$\mathbb{1}_i$	-0.0014	-0.1084***
	(0.021)	(0.037)
Observations	336	336
R^2	0.318	0.137
$\beta_{\Delta TR_{it}}+\beta_{\{\mathbb{1}_i \cdot \Delta TR_{it}\}}$	0.9875	-0.4560
95% CI	[0 .797, 1.178]	[-0.759, -0.153]
$\beta_{\Delta TR_{i,t-1}}+\beta_{\{\mathbb{1}_i \cdot \Delta TR_{i,t-1}\}}$	0.4485	
95% CI	[0.097, 0.800]	

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

F Evidence in favor of validity of the exclusion restriction of ΔMC_t

We need to verify if being an economically important province could represent a potential violation of the exclusion restriction of W_{it} through ΔMC_t. In Table F.1, we compute two alternative specifications of the basic regressions. In Panel (H), we eliminate from the sample CABA, Buenos Aires, Córdoba and Santa Fe, the four biggest provinces in economic terms. The estimated coefficients are visually almost identical to those that appear in Panel (B) in Table 2, suggesting that these big provinces provinces do not seem to drive the main results.

Then, in Panel (I), we estimate the model adding the change of the GPP/GDP ratio, $\Delta\left(GPP/GDP\right)_{it}$, as a control. The inclusion of this control has an insignificant effect on the fiscal reactions; furthermore, the other estimated coefficients are visually quite similar than those of our chosen specification.

Table F.1: Concern regarding big provinces

	(H)		(I)	
	ΔG_{it}	ΔD_{it}	ΔG_{it}	ΔD_{it}
ΔTR_{it}	0.9792***	-0.3276***	0.9845***	-0.3329***
	(0.219)	(0.103)	(0.207)	(0.099)
$\Delta TR_{i,t-1}$	0.3226***		0.3291***	
	(0.071)		(0.073)	
ΔR_{it}	-0.1275	-1.3860***	-0.1380	-1.4176***
	(0.367)	(0.504)	(0.376)	(0.412)
$\Delta R_{i,t-1}$	0.1653		0.1766	
	(0.962)		(0.467)	
$\Delta\left(GPP/GDP\right)_{it}$			0.0610	0.0846
			(0.072)	(0.069)
Constant	0.0061	0.1564***	0.0073	0.1414***
	(0.012)	(0.029)	(0.010)	(0.025)
Anderson-Rubin test	20.13***	20.59***	22.41***	22.22***
Number of clusters	20	20	24	24
Observations	280	280	336	336
R^2	0.321	0.107	0.317	0.108

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

G Robustness checks

We explore the robustness of our chosen specification by using other estimation methods, incorporating some controls, and changing the specification's lag structure.

First, note that when using 2SLS, we assume that errors both were (a) independent from one another and (b) normally distributed, which may be inefficient in this setting. Specifically, because changes in public expenditure and debt are simultaneously chosen by provincial governments, the error terms ν_{it} and η_{it} may be correlated. In order to address this concern, we estimate (8) and (9) as a system using 3SLS. We also assume implicitly that errors were normally distributed, which may be unneccessarily restrictive. To address this issue, we followed a distribution-free approach by estimating (8) and (9) using GMM.

Since provinces had almost no leeway to improve their tax collection between 1988 and 2003, we considered such tax collection a fixed, tiny fraction of private sector output. However, private sector output overall may have changed in some provinces, information that was not included in Table 2. This omission may give an incomplete view of local public finances in Argentina. Due to the lack of availability of accurate data of provincial private output for these years, and although its use may raise some concerns, we incorporate contemporaneous and one-period lagged changes in the GPP net of local tax collection, ΔY^n_{it} and $\Delta Y^n_{i,t-1}$, respectively, to control for shocks to provincial tax bases.

Finally, we test the sensitivity of our results under different dynamic specifications (e.g., adding and excluding different lags of our explanatory variables).

For all these robustness checks, our second stage results are reported in Table G.1.

Table G.1: Robustness checks

	(J)		(K)		(L)		(M)	(N)
	System (3SLS)		GMM		With net GPP		Excluding $\Delta TR_{i,t-1}$ and $\Delta R_{i,t-1}$	Adding $\Delta TR_{i,t-1}$ and $\Delta R_{i,t-1}$
	ΔG_{it}	ΔD_{it}	ΔG_{it}	ΔD_{it}	ΔG_{it}	ΔD_{it}	ΔG_{it}	ΔD_{it}
ΔTR_{it}	0.9925***	-0.3344***	0.877***	-0.401**	0.9814***	-0.2820**	0.8965***	-0.3679***
	(0.151)	(0.123)	(0.286)	(0.169)	(0.226)	(0.129)	(0.226)	(0.091)
$\Delta TR_{i,t-1}$	0.3909***		0.306*		0.3145***			-0.2137
	(0.110)		(0.177)		(0.092)			(0.250)
ΔR_{it}	-0.1076	-1.4005**	-0.258	-1.513***	-0.1157	-1.3778***	-0.1193	-1.4579***
	(0.548)	(0.710)	(0.859)	(0.206)	(0.366)	(0.403)	(0.452)	(0.417)
$\Delta R_{i,t-1}$	0.0976		0.182		0.1397			0.245
	(0.323)		(0.839)		(0.387)			(1.160)
ΔY^n_{it}					-0.0017	-0.0152		
					(0.009)	(0.014)		
$\Delta Y^n_{i,t-1}$					0.0046			
					(0.012)			
Constant	0.0069	0.1413***	0.009	0.140***	0.0068	0.1430***	0.0029	0.1420***
	(0.007)	(0.024)	(0.015)	(0.014)	(0.010)	(0.025)	(0.008)	(0.026)
Anderson-Rubin test					10.15***	12.56***	21.87***	22.28***
Number of clusters	24	24	24	24	24	24	24	24
Observations	336	336	336	336	336	336	336	336
R^2	0.314	0.106			0.316	0.114	0.272	0.113

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

Notably, all results are very similar to those reported in Panel (B) in Table 2. In particular, in Panel (L), the estimated coefficients of the controls are statistically and economically not significant, suggesting that changes in the proxy for provincial private output do not have an impact on fiscal reactions. Moreover, the inclusion of these controls did not modify the other estimated coefficients. These results, some of which are analogous to those obtained by Végh and Vuletin (2015), reflect in part the very limited capacity of Argentine provinces to react to changes in their tax base.[43] Panel (M) excludes one-period lagged changes of our explanatory variables in the public consumption regression, while Panel (N) adds one-period lagged changes in both sources of provincial revenue in the debt equation. In other words, Panel (M) estimates (8) and (9) only focusing on the contemporaneous effect of changes in provincial revenue, whereas Panel (N) estimates them with contemporaneous and one-period lagged changes in both Coparticipation transfers and royalties. The estimated coefficients reveal both that our results are not sensitive to these exercises, and also that the AIC and BIC statistics of these exercises are higher than those of our chosen specification.[44] In particular, the results in Panel (N) seem to give further support to our theoretical model, in the sense that the inclusion of one-period lagged changes in both sources of provincial income did not impact the provinces' debt management decisions. Indeed, the new estimated coefficients are insignificant, while the others remain almost unaltered.

H Volatility of Coparticipation transfers and royalties in hydrocarbon-producing provinces

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

First, Table H.1 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.

Next, for both sources of provincial revenue, we compute the annual accumulated coefficient of variation, starting from 1989 and taking the average among these eight provinces. Figure H.1 depicts the results. Clearly, the volatility of royalties is, year af-

[43]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.

[44]The AIC and BIC statistics of the public consumption regressions are −161.98 and −142.89 (Panel (B) in Table 2) and −145.45 and −133.99 (Panel (M) in Table G.1), respectively. Meanwhile, the AIC and BIC statistics of the debt regressions are 51.8 and 63.27 (Panel (B) in Table 2) and 52.55 and 71.64 (Panel (N) in Table G.1), respectively.

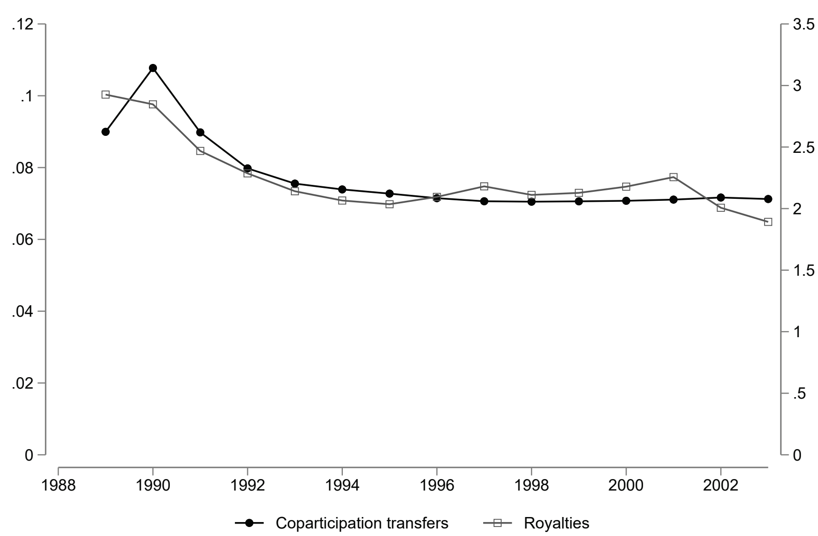
Table H.1: Average coefficient of variation by source of revenue, by province

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

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

ter year, higher than that of Coparticipation transfers.

Figure H.1: Average accumulated coefficients of variation, by source of revenue



Notes: 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. Sources: *Dirección Nacional de Relaciones Económicas con las Provincias*, and own calculations.

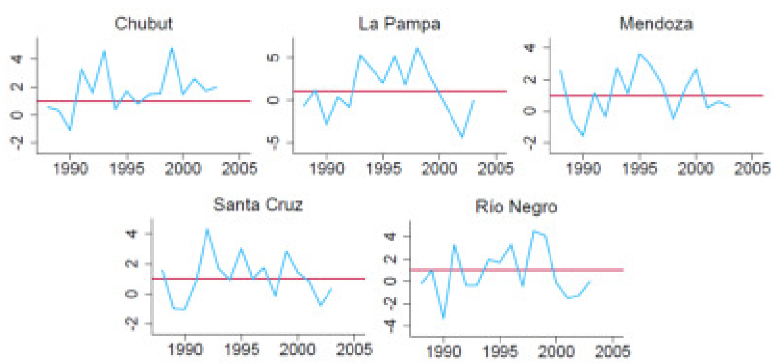
I The evolution of hydrocarbon production between 1988 and 2003

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 Res_{jt}), d_{jt}, and production in the same year q_{jt}. A result greater or equal to one means that the quantity of hydrocarbon that is discovered is the same as or greater than that which is extracted, so production is not at a depletion stage. Figure I.1 depicts the rate RRR_{jt} for the five high-depletion-indexed, hydrocarbon-producing provinces between 1988 and 2003.

Figure I.1: Reserve replacement rate, by province



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

The rate RRR_{jt} was above one for most of the years. In fact, for four of these provinces, the average RRR_{jt} was strictly above one. Regarding Río Negro, although its average reserve-replacement rate was 0.762, we cannot reject the null hypothesis that it is statistically equal to one.

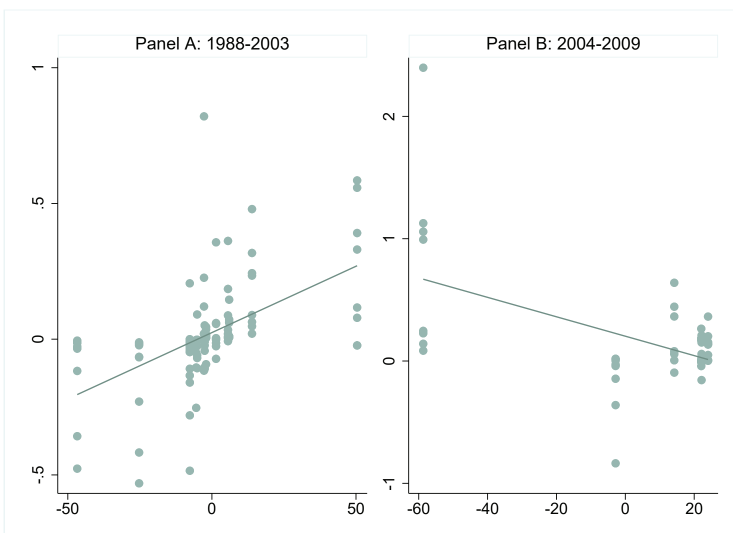
J Supplementary material

Table J.1: Public consumption (as percent of provincial expenditure)

Province	Public consumption	Province	Public consumption
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

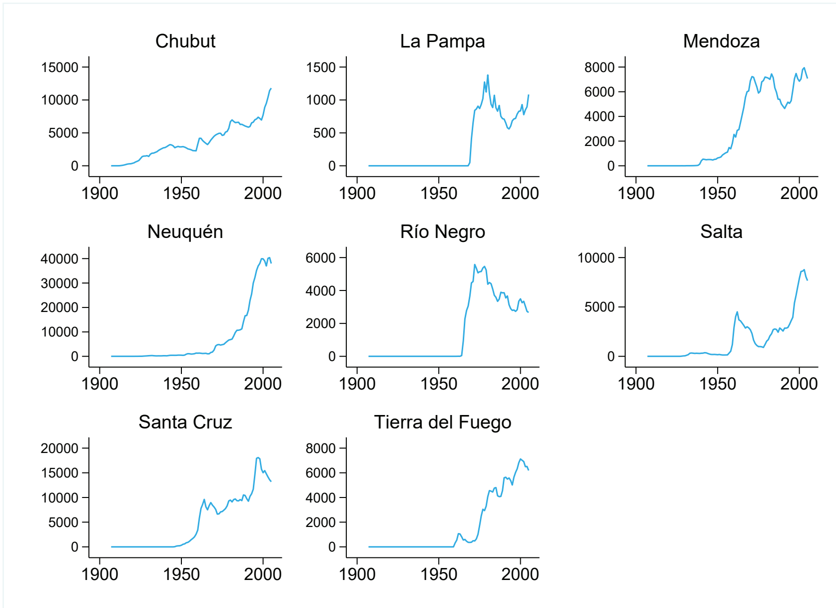
Source: *Dirección Nacional de Relaciones Económicas con las Provincias*.

Figure J.1: Changes in the international oil price and in hydrocarbon royalties



Notes: 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 J.2: Historical production of hydrocarbons, by province



Notes: Production is measured in thousands of m^3 of oil equivalents. 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. Sources: IAP (1967), *Anuario de Combustibles*, *Instituto del Petróleo y del Gas*, and own calculations (see Online Appendix OA.12, where we explain how we build the data that underlay Figures 3 and J.2).

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