The Assignments of the VAT and the Hydrocarbons Tax in Spain

As atribuições do IVA e do imposto sobre hidrocarbonetos na Espanha

Las cesiones del IVA y del Impuesto sobre Hidrocarburos en España

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ABSTRACT
The Financing System of the Autonomous Communities in Spain, in force since 2009, set the assignment of the liquid collection of the 50% Income Tax, which tax rate approves each Autonomous Community; the assignment of net Value Added Tax (VAT) collection of 50%. In addition, the Harmonized Excise Duties of 58% are the main significant the Hydrocarbons Tax (HYT). The regional tariff and the transfer of VAT and HYT are tax resources subject to settlement, by which the Autonomous Communities get collection through the payments on account system of the current year and the final settlement two years later. This work aims to study the collection of VAT and the HYT and the possible inefficiencies that may arise. The methodology estimates a dynamic data panel from 2003-2021, using the estimator of instrumental variables (IV) and its generalization by the Generalized Estimator of Moments (GMM). According to the results, the regional tax on income rate (RTR) influenced the collection of harmonized taxes VAT and HYT. Therefore, some externalities arose regarding the collection of those taxes.

Keywords: fiscal federalism, assigned taxes, payments on account, efficiency, dynamic panel.

RESUMO
O Sistema de Financiamento das Comunidades Autônomas na Espanha, em vigor desde 2009, estabeleceu a atribuição da arrecadação líquida do Imposto de Renda de 50%, cuja alíquota aprova cada Comunidade Autônoma; a atribuição da arrecadação líquida do Imposto sobre Valor Agregado (IVA) de 50%. Além disso, os Impostos Especiais de Consumo Harmonizados de 58% são o principal e significativo Imposto sobre Hidrocarbonetos (HYT). A tarifa regional e a transferência do IVA e do HYT são recursos tributários sujeitos a liquidação, por meio dos quais as Comunidades Autônomas obtêm a arrecadação através do sistema de pagamentos por conta do ano corrente e a liquidação final dois anos depois. Este trabalho tem como objetivo estudar a arrecadação do IVA e do HYT e as possíveis ineficiências que possam surgir. A metodologia estima um painel de dados dinâmico de 2003 a 2021, usando o estimador de variáveis instrumentais (IV) e sua generalização pelo Estimador Generalizado de Momentos (GMM). De acordo com os resultados, a alíquota do imposto regional sobre a renda (RTR) influenciou a cobrança dos impostos harmonizados VAT e HYT. Portanto, surgiram algumas externalidades com relação à cobrança desses impostos.

Palavras-chave: federalismo fiscal, impostos atribuídos, pagamentos por conta, eficiência, painel dinâmico.

RESUMEN
El Sistema de Financiación de las Comunidades Autónomas en España, vigente desde 2009, establece la asignación de la recaudación líquida del 50% del IRPF, cuyo tipo impositivo aprueba cada Comunidad Autónoma; la asignación de la recaudación líquida del 50% del Impuesto sobre el Valor Añadido (IVA).

Además, los Impuestos Especiales Armonizados del 58% son los principales significativos el Impuesto sobre Hidrocarburos (HYT). La tarifa autonómica y la cesión del IVA y del HYT son recursos tributarios sujetos a liquidación, por los que las Comunidades Autónomas obtienen la recaudación mediante el sistema de pagos a cuenta del año en curso y la liquidación definitiva dos años después. Este trabajo tiene como objetivo estudiar la recaudación del IVA y del HYT y las posibles ineficiencias que puedan surgir. La metodología estima un panel de datos dinámico desde 2003-2021, utilizando el estimador de variables instrumentales (IV) y su generalización mediante el Estimador Generalizado de Momentos (GMM). De acuerdo con los resultados, la tasa del impuesto regional sobre la renta (RTR) influyó en la recaudación de los impuestos armonizados IVA e HYT. Por lo tanto, surgieron algunas externalidades en relación con la recaudación de dichos impuestos.

Palabras clave: federalismo fiscal, impuestos cedidos, pagos a cuenta, eficiencia, panel dinámico.

1 INTRODUCTION

In Spain, Law 22/2009, of December 18 on the Autonomous Communities Financial System (AFS) set that the financing of regional governments consists of tax capacity, the Guarantee Fund for Fundamental Public Services, the Global Sufficiency Fund, and the convergence funds[1]. Tax capacity is defined as the collection, besides traditional taxes transferred, the assignment of the liquid collection of the 50% Income Tax, which tax rate approves each Autonomous Community, of the 50% of the VAT, of the 58% of the Harmonized Excise Duties; 100% of the liquid collection of the Electricity Tax, and the complete collection of the Tax on Deposits in Credit Institutions. Besides, from 2023, the complete collection of the Tax on landfilling, incineration, and co-incineration of waste[2].

Consequently, Law 22/2009 is to increase the assignment tax instead of general transfers[3]. The collection of HYT is the most important of the harmonized excise duties; also, the collection of VAT is 32% on average of regional governments' tax capacity, and the collection of HYT is 6,64% on average. In addition, in Spain, assignment taxes from income tax, VAT, and HYT get all the government levels: State, regional, and local governments[4]. Otherwise, the COVID-19 pandemic recession is supposed to increase spending and decrease the revenues of regional governments. The State has assumed the cost of this shock by providing additional resources outside the funding system through non-returnable transfers (Covid-19 Fund, special transfers). Like the 2008 recession, the State kept the payments on account based on the forecast before the recession. In 2022, regional governments would not return the negative settlement of the resources subject to liquidation (De la Fuente, A., 2024).

[1] Law 22/2009, of December 18, regulates the financing system of the Autonomous Communities of Common Regime and Cities with Statute of Autonomy.
[2] Law 7/2022, of April 8, on waste and contaminated floors for a circular economy.
[3]According to the AFS set in 2001, the tax capacity of each Autonomous Community is defined by the regional Income Tax, corresponding to 33% of Income Tax yield, the transfer of the liquid collection of 35% of the VAT, and 40% of the Harmonized Excise Duties (Law 21/2001, of December 27, which regulates the fiscal and administrative measures of the new financing system of the Autonomous Communities of the common regime and Cities with a Statute of Autonomy).
[4] Cities with populations exceeding 75.000 inhabitants or are provincial capital have an assignment from the liquid collection of Income Tax (2,1336%), VAT (2,3266%), and Harmonized Excised Duties (2,9220%).

According to Law 22/2009 (Article 11), Autonomous Communities receive the tax capacity subject to liquidation monthly financing corresponding to the payments on account. The corresponding final settlement is for the difference between the final values of collection and the payments on account two years later because liquid Income Tax is known on that date. This work studies possible inefficiencies regarding the collection, through the payments on account system, of the VAT and the HYT by regional governments in Spain[5]The methodology estimates a dynamic data panel from 2003 to 2021, using the estimator of instrumental variables (IV) and its generalization by the Generalized Estimator of Moments (GMM).

Previously, payments on account of regional Income Tax have been studied (Arner, A. 2021b, 2022b). These works show that in the current AFS, there were vertical and horizontal externalities because the tax base is the same for the State and regional income taxation. Also, there was some reaction of the tax rate in one region to the tax rate of others. Subsequently, transfers from the State must internalize such externalities. The main results of the current study were that the regional tax on income rate also influences the collection of harmonized taxes VAT and HYT; subsequently, some inefficiencies arose regarding the collection of those taxes. Concerning VAT, horizontal externalities refer to redistribution between regional governments. Meanwhile, the collection of HYT showed a vertical externality when autonomic tax rates are applied, and horizontal externalities.

In addition to this introduction, this work consists of the following sections. Section 2 refers to the review of economic literature. Section 3 shows the main aspects of the collection of VAT and HYT by regional governments in Spain. Methods are addressed in Section 4. Results are discussed in section 5. The last section shows the main conclusions.

2 LITERATURE REVIEW

The conventional theory of fiscal federalism concerning the allocation of taxes establishes that subcentral governments in a federation have mainly transferred revenues (Tiebaut, 1956; Olson, 1956; Oates, 1972). Gordon (1983) pointed out inefficiencies a local government can create for nonresidents through public goods and taxation decisions. Others, such externalities occur if tax revenues received in other communities may change due to the spillover of economic activity or resource costs for public services in other communities. Finally, it is if distributional effects among no residents would be ignored. The central government could coordinate local tax and expenditure policies through revenue sharing and matching grants as a solution.

Keen (1997) defines such inefficiencies as vertical and horizontal externalities. This work finds that federal structures raise the possibility of vertical tax externalities arising from the concurrent taxation

[5] The Autonomous Community of Canary is excluded from the territory where VAT and special duties are applied because of the Canary indirect general Tax.

of the same tax base between state and federal governments[6]. Furthermore, vertical tax externalities may have implications for distributional policy. In order to eliminate vertical externalities, it is supposed to allocate all tax powers to just one level of government and finance the other by a vertical transfer. Subsequently, vertical transfers aim to avoid inefficiencies from tax base overlap and externalities in horizontal relations between states because of efficiency concerns. In addition, Dahlby and Wilson (2003) say vertical fiscal externalities occur if a federation of taxes or expenditures of one level affects the budget constraint of another level of government.

According to Agrawal et al. (2024a), the co-occupancy of tax bases also arises concerning the provision of public services. Broadway et al. (1998) highlight the conflicting fiscal externalities for the extent of redistribution of progressive income tax and public good supply in a decentralized federation. Furthermore, regional governments compete away regarding redistributive objectives, known as horizontal externalities. For these authors, if one state increases its tax rate on a given base, its tax base will fall because of elasticity in the base supply and cross-border mobility. The result can be inefficiency in allocating resources across and within jurisdictions or nonoptimal redistributive policies. To solve this problem, these authors think the federal government must retain enough instruments to correct any pressure toward inefficiently low state taxes.

Other standpoints are from Wildasin (1991), who shows how a system of matching grants from a federal government to state governments can neutralize the effect of migration on state redistribution policies. Wellisch (1993) demonstrated that the Nash equilibrium with transfers yields efficient public-good levels even in the presence of spillovers, obviating the need for central intervention. In addition, Hoyt (2001) shows that if federal or state governments pursue coordinated policies, high taxes on the same bases at the local or state levels of government will lead to low taxes or possibly subsidies on the same bases. Even with multiple tax instruments, the co-occupancy of tax bases will not eliminate vertical fiscal externalities when the separate tax bases are interrelated (Hoyt, 2017).

Ogawa and Wildasin (2009) show a more critical feature; they analyze models with inter-jurisdictional spillovers that affect the global environment. These authors think jurisdictions interact not only through pollution or other spillovers but also through an integrated and competitive market for capital or some other resource linked to the production of spillover effects. Governments are free to tax (or subsidize) this competitively traded resource. Consequently, decentralized taxation is essential because the competition allocation of capital would equalize capital productivity in all locations. Opposite, Agrawal et al. (2022) propose a centralized provision of the public good if jurisdictions attempt to avoid a loss of mobile capital, which confers a positive horizontal fiscal externality on neighbors by keeping the capital tax low, an outcome that leads to inefficient under provision of the public good.

[6] This work uses the noun of *state* for different governments in a federation.

Otherwise, tax competition involves strategic interactive relationships between subnational governments to attract or retain mobile tax bases (Lago et al., 2022). According to Agrawal (2024b), states and local governments can compete for cross-border shoppers and businesses in different places by changing the retail sales Tax or value-added Tax. The sales tax case is one in which the tax base is locally mobile, so strategic interactions are expected to arise. Quickly expanding remote sales led to tax compliance and moved from sellers in storefronts to buyers purchasing from out-of-state firms. Bruce et al. (2023) point out that sales tax base erosion has stemmed from greater tax competition from untaxed jurisdictions and remote sales.

Empirical assessments have studied vertical externalities in the tax policy design in the income and sales tax. Besley and Rosen (1998) suggest that when the federal government increases taxes, there is a significant positive response to state taxes, being results that a 10% per gallon increase in the federal Tax on gasoline rate leads to a 3,2% in the state tax; also, a 10% increase in the federal unit Tax on cigarettes leads to a 2,8% increase in the state cigarette unit tax. Besides, Esteller-Moré and Solé Ollé (2001) found that an increase of 1% in the effective federal Tax on income represents an increase in the collecting state tax of 10%; this increase is 0,22% for the Income Tax and Sales Tax.

Opposite, Goodspeed (2000) saw an increase of 1% in federal Income Tax, implying that local Income Tax decreased by 0,17%. Hayashi and Boadway (2001) show that while provincial tax rates respond negatively to the federal tax rate, at least some provinces increase their tax rates in response to increases in the tax rates of other provinces. However, Esteller-Moré and Solé Ollé (2002) found an increase in the regional tax rates of 20% followed by an increase in Canadian federal Income Tax of 1%; also, a 1% change in the tax rates of competing provinces forces an increase in the tax rates of competing provinces of 0,3%.

3 THE ASSIGNMENTS OF THE VAT AND HYT TO REGIONAL GOVERNMENTS

3.1 THE COLLECTION OF VAT

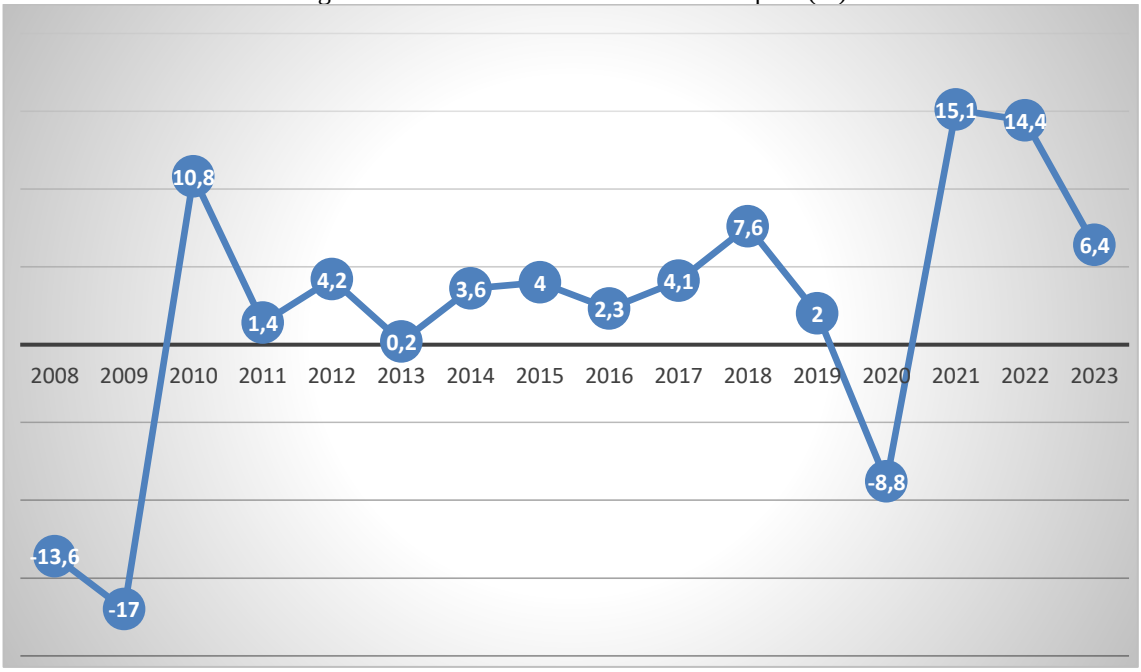
The evolution of VAT tax collection (Figure 1) for 2008-2023 is characterized by two main break points in 2008, subsequent financial recession and 2020 due to the pandemic (Figure 1). Furthermore, Figure 1 shows that in 2008 and 2012, VAT collection increased because of tax rates rising in Spain[7]. In addition, Table 1 shows current differences in each country in the EU regarding VAT tax rates applied on harmonized excise duties on derivatives.

Law 22/2009 (Article 13) establishes that regional governments will participate in the net collection of VAT obtained each year by determining a payment on account of the final performance. It is based on the budgetary forecast of VAT collection and provisional regional demand indexes applying

[7] The VAT tax rate increased from 16% to 18% in 2008 and from 18% to 21% in 2012.

the formula in Table 2. The final statement of assessment shall be established by the difference between the definitive value of the transfer of the net VAT revenue resulting from the final values of the collection and demand indexes and the payments on account received in respect to VAT in that year (Table 3).

Figure 1. Evolution of VAT collection in Spain (%)



Source: AEAT (2023)

Table 1. Excises on derivates in euros per unit (in parenteses VAT)

Country	Since:	Euro-super 95 1000 l	Gas oil automobile 1000 l	Gas oil 1000 l	Fuel oil t
Austria	10/06/2013	482 (20)	397 (20)	98 (20)	60 (20)
Belgium	01/04/2023	600,16 (21)	600,16 (21)	18,65 (21)	16,35 (21)
Cyprus	01/11/2023	359 (19)	330 (19)	52,61 (19)	15 (19)
Germany	01/01/2023	654,5 (19)	470,4 (19)	61,35 (19)	25 (19)
Estonia	01/05/2020	563 (20)	372 (20)	58 (20)	235 (18)
Spain	01/01/2019	472,69 (21)	379 (21)	96,71 (21)	17 (21)
Finland	01/01/2021	722,41 (24)	510,52 (24)	275,8 (24)	64,5 (22)
France	01/01/2024	691,3 (20)	608,9 (20)	156,2 (20)	139,5 (20)
Greece	01/07/2017	700 (24)	410 (24)	280 (24)	38 (24)
Croatia	04/07/2023	456 (25)	383 (25)	56,14 (25)	21,24 (25)
Ireland	11/10/2023	606,39 (23)	526,83 (23)	149,09 (13,5)	173,26 (13,5)
Italy	01/01/2023	728,4 (22)	617,4 (22)	403,21 (22)	31,39 (10)
Lithuania	01/01/2020	466 (21)	372,9 (21)	43,46 (21)	52
Luxembourg	01/01/2024	548,64 (17)	440,86 (17)	103,73 (14)	15 (22)
Latvia	01/11/2023	509 (21)	414 (21)	56,91 (21)	
Malta	01/01/2016	549,38 (18)	472,4 (18)	232,09 (18)	30 (18)
Netherlands	01/07/2023	789,1 (23)	516,25 (23)	174,65 (23)	18,9 (23)
Portugal	26/09/2023	450,36 (23)	303,54 (23)	330 (23)	15,65 (13)
Slovenia	05/12/23	460,51 (22)	392,67 (22)	115,77 (22)	15,02 (22)
Slovakia	05/12/2023	514 (20)	368 (20)	25,95 (20)	111,15 (20)

Source: Weekly Oil Bulletin (2024)

Table 2. Payments on account for the assigned VAT to regional governments

$PVAT_i(t) = 50\% * PCVAT(t) * RDI_i(t) * 0{,}98$	
$PVAT_i(t)$	The annual amount of the State's advance must be paid to the Autonomous Community in the concept of payment on account of the VAT collection in year *t*.
$PCVAT(t)$	VAT planned collection for year *t*.
$RDI_i(t)$	Planned demand index to the Autonomous Community *i* for year *t*.
0,98 is an adjustment index	

Table 3. Final settlement of the VAT in 2021 (thousands of €)*

Autonomous Community	**RDI [1]**	**CVAT [2] = A* [1]**	**PVAT [3]**	**Final Settlement [4] = [2] - [3]**
Cataluña	19,622737	7.113.077,15	7.165.445,82	-52.368,67
Galicia	5,765169	2.089.825,28	2.141.198,86	-51.373,58
Andalucía	17,250728	6.253.243,84	6.091.738,21	161.505,63
Asturias	2,240145	812.033,72	863.165,81	-51.132,09
Cantabria	1,375724	498.688,38	515.551,41	-16.863,03
La Rioja	0,694301	251.678,27	262.633,32	-10.955,05
Murcia	3,030116	1.098.391,57	1.082.220,56	16.171,01
Valencia	11,606267	4.207.174,19	4.112.433,07	94.741,12
Aragón	3,032155	1.099.130,69	1.164.274,95	-65.144,26
C.-La Mancha	3,995233	1.448.238,37	1.491.376,74	-43.138,37
Extremadura	1,910738	692.626,46	718.744,65	-26.118,19
Baleares	4,040459	1.464.632,41	1.373.883,03	90.749,38
Madrid	20,050505	7.268.139,46	6.727.720,40	540.419,06
Cast. y León	5,385723	1.952.279,30	2.050.793,17	-98.513,87
Total	**100,00**	**36.249.159,09**	**35.761.180,00**	**487.979,09**

*100% CVAT (before payment to the Autonomous Communities and the Municipalities): 72.498.318,17; 50% Revenue ceded to the Autonomous Communities (A): 36.249.159,09
Source: Ministry of Finance (2023a)

3.2 THE COLLECTION OF HYT

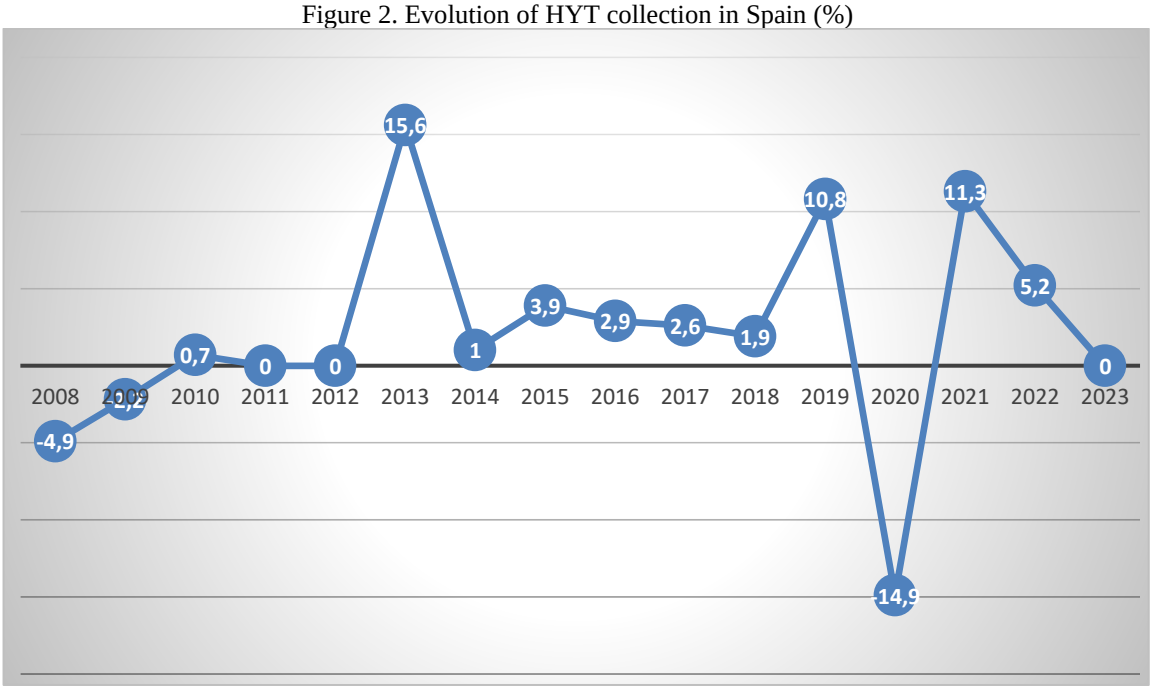
The evolution of the HYT collection (Figure 2) for 2008-2022 is characterized by two main break points in 2013 and 2020. In 2013, Hydrocarbon Tax performance was about new regulations regarding the Tax on Retail Sales of certain hydrocarbons (RSHYT). In 2020, the COVID-19 pandemic justified such evolution because of the demand for hydrocarbon products. The RSHYT was created in 2001 as a State tax entirely assigned to the Autonomous Communities, which taxes sales of hydrocarbons as imports and acquisitions to other EU countries[8]. Its yield was affected by the financing of health expenses, which was called *sanitary cent*; also, the autonomic rate was affected by environmental expenses. Products taxed by RSHYT were gasoline, diesel, fuel oil, kerosene, bioethanol, and biodiesel[9]. The tax rate consisted of two sections: one State, in force in all the Autonomous Communities, and another autonomous, whose implementation must be agreed upon by each Autonomous Community by Law of its Parliament or Assembly (Table 4)[10].

[8] Law 24/2001, of December 27 on Fiscal, Administrative, and Social Order Measures.

[9] Lubricants are not levied; for that product there is an extended responsibility regimen of the productor in which payment from the lubricants producer finance the correct management of waste oils (Arner, A., 2021a, 2022a).

[10] The State rate of RSHYT in 2009 was 24€/1.000 liters (gasoline), 24€/1.000 liters (gasoil), 6€/1.000 liters (gasoil special uses), 1€/1 t (fuel oil), and 24€/1.000 liters (kerosene).

Figure 2. Evolution of HYT collection in Spain (%)



Source: AEAT (2023)

Table 4. RSHYT collection (thousands of €)

Date	RSHYT (normative)	RSHYT (definitive)
2002	752.977,51	752.977,51
2003	720.237,98	851.476,59
2004	828.046,02	1.000.621,34
2005	845.894,21	1.112.466,81
2006	863.866,57	1.251.443,49
2007	888.114,75	1.283.183,41
2008	848.568,56	1.225.407,57
2009	795.257,40	804.192,82
2010	788.094,35	788.094,35
2011	755.922,32	755.922,32
2012	700.726,83	700.726,83
2013	179.349	179.349

Own source from Ministry of Finance (various years)

Law 22/2009 (Article 16) is updated from January 1, 2013, because Spain undertook to repeal the RSHYT by Law 2/2012, of June 29, on the General State Budget because the requirements of Directive 92/12/CEE to set up non-harmonized taxes on topics already taxed by harmonized taxes. The RSHYT was integrated into the HYT, although the differences in tax rates were maintained by Autonomous Communities in force in 2012[11]. Consequently, from January 1, 2013, there are known three sections for the HYT: the general tax rate, equal to before HYT; the special tax rate, which replaces the State rate of the repealed RSHYT; and the autonomic rate, which replaces the autonomous rate of the RSHYT, and which, like this, must be established by each Autonomous Community (Table 5)[12].

[11] It was under the Article 18 of the proposal for a Directive amending Directive 2003/96/EC restructuring the Community framework for the taxation of energy products and electricity, published by the European Commission on April 13, 2011, which allows for a regional differentiation of tax rates on some of these products.

[12] In the HYT, the devolution regimen is for professional use of petrol (industrial factories, commodities transport, travelers

Meanwhile, the collection of the RSHYT until 2012 was by monthly transfers; since 2013, the tax capacity is subject to settlement. From January 1, 2019, the derogation of the regional rate was mandated to be incorporated into the special State rate, as double the State rate, which is the maximum rate Autonomous Communities could establish (article 52 of Law 22/2009). Subsequently, HYT collection again significantly increased in 2013 and 2019 (Figure 2)[13].

Table 5. State rates and the autonomic HYT rate collection in 2018
(€/1000 liters, for fuel €/t)

State rates/ Autonomous Community	*Euro-super 95*	*Gas oil Autom.**	*Gas oil***	*Fuel oil*	*Kerosene*	*Biodiesel*
State rate (general)	400,69	306,00	78,71	14,00	306,00	307,00
State rate (special)	72,00	72,00	18,00	3,00	72,00	72,00
Cataluña	48,00	48,00	6,00	2,00	48	48
Galicia	48,00	48,00	0,00	2,00	48	48
Andalucía	48,00	48,00	0,00	2,00	48	48
Asturias	48,00	40,00	6,00	2,00	48	48
Cantabria	0,00	0,00	0,00	0,00	0	0
La Rioja	0,00	0,00	0,00	0,00	0	0
Murcia	48,00	48,00	6,00	2,00	48	48
Valencia	48,00	48,00	0,00	2,00	48	48
Aragón	24,00	24,00	0,00	0	0	24
C.-La Mancha	48,00	4,00	4,00	2	48	48
Extremadura	38,4,	38,40	0,00	1,6	38,4	38,4
Baleares	48,00	48,00	12,00	2	48	48
Madrid	17,00	17,00	4,25	0,70	17	17
Cast. y León	0,00	0,00	0	0	0	0

* Devolution regarding general type at 1 € by 1000 liters and for the special type at 24 € by 1000 liters (the maximum account is 50.000 liters per vehicle/year and 5.000 liters by taxi/per year). Also, Autonomous Communities set the autonomic tax rate of refund for the professional use of gas oil from that rate.
**Devolution for agriculture and farmers results from applying the tax rate of 63,71€ by 1000 liters.
Source: Ministry of Finance (2023b)

Law 22/2009 (Article 16) set regional governments to participate in the net collection HYT each year by determining a payment for the final performance. It is based on a budgetary forecast of HYT collection by applying the general and special tax rate and the provisional regional indexes of supplies of petrol, diesel, and fuel oils, according to data from the Ministry of Industry, Energy and Tourism weighted by the corresponding State tax rates, general and special, applying the formula in Table 6. The amount obtained as a payment on account will be paid to each Autonomous Community monthly and processed as a refund of income under the HYT concept. The final settlement will be determined by the difference between the final value of the assignment of the net collection for the State rates of the HYT resulting from applying the previous formula and the payments on account received for HYT that year (Table 7).

transport, taxis) and gasoil use by agriculture and farmers. Also, the regional governments set a tax rate for the gas oil devolutions, the most essential product concerning HYT collection.

[13] Under the judgment of February 27, 2014, of the Court of Justice of the European Union, the RSHYT was reimbursed to taxpayers corresponding to 2010-2012 by the Spanish Agency of Tax Administration (AEAT). On June 20, 2024, the Justice Court of the UE (CJEU) declared the application of the regional section of the RSHYT between 2013 and 2018 illegal.

Table 6. Payments on account for the assigned HYT to regional governments

*PHYTi(t) = [58% * CHYT1(t) + 100% * CHYT2 (t)]*RWDIi(t) *0,98*	
PHYTi(t)	The annual amount of the advance to the Autonomous Community i, as a payment on account of the collection of the State rates of the HYT obtained in year (t).
CHYT1(t)	Net revenue expected from the HYT in year (t), derived from the application of the *general State rate*.
CHYT2(t)	Net revenue expected from the HYT in year (t) derived from the application of the *special State rate*.
RWDIi(t)	Provisional index according to data from the Ministry of Industry of deliveries of gasoline, diesel and fuel oils, weighted by the corresponding State tax rates, of the Autonomous Community i for the year (t). *0,98 is an adjustment index*

Table 7. Final settlement of the CHYT in 2021 from the application of the State rates **(thousands of €)***

Autonomous Community	RWDI [1]	CHYT [2] = A + B	PHYT [3]	Final Settlement [4] = [2] - [3]
Cataluña	18,347261	1.380.320,97	1.473.425,43	-93.104,46
Galicia	7,017901	527.978,33	545.137,75	-17.149,42
Andalucía	18,326701	1.378.774,16	1.403.102,45	-24.328,29
Asturias	2,187935	162.348,07	169.316,39	-6.968,32
Cantabria	1,530538	115.147,11	120.651,04	-5.503,93
La Rioja	0,705368	53.067	59.473,29	-6.406,29
Murcia	4,406746	331.533,10	333.409,15	-1.876,05
Valencia	11,187521	841.671,69	855.004,06	-13.332,37
Aragón	4,575965	344.263,97	334.193,71	10.070,26
C.-La Mancha	6,550288	492.798,31	500.899,97	-8.101,66
Extremadura	3,174483	238.826,14	244.661,68	-5.835,44
Baleares	2,672502	201.060,59	224.556,88	-23.496,29
Madrid	10,870251	817.802,48	905.530,52	-87.728,04
Cast. y León	8,476538	637.716, 07	666.776,49	-29.060,42
Total	**100,00**	7.523.307,98	1.473.425,43	**-312.830,83**

*100% CHYT from the general rate (before payment to the Autonomous Communities and the Municipalities): 9.461.144,11
58% of revenue transferred to the Autonomous Communities (general rate) (A): 5.487.463,59
100% CHYT from special rate (before payment to the Autonomous Communities and the Municipalities): 2.035.844,40
100% Revenue ceded to the Autonomous Communities (special type) (B): 2.035.844,40
Source: Ministry of Finance (2023a)

4 METHODOLOGY

The dynamic panel data model plays a crucial role in understanding the settlement of the ACS. It is because the relationship between the variables involved in the settlement is dynamic, with the final settlement being the difference between the final values and the payments on account perceived two years before. According to Hausman and Taylor (1981), one of the main advantages of panel data estimation is controlling individual, unobservable effects correlated with other variables in the specification, which the individual study of each cross-section does not identify.

The model estimate, characterized by including a lagged dependent variable in the right term of the equation, reinforces the persistence of the panel equation. This is due to the addition of dynamic structures, such as the unobservable individual effect (ηi), and the inertia induced by the autoregressive mechanism of the equation (Angulo and Mur, 2004). Arellano and Bond (1991) for that model proposed

a generalized method of the moments (GMM) procedure based on additional instruments obtained from the orthogonality conditions between lagged values of independent variables and the disturbances (Baltagi, 2021).

The estimates of the VAT Dynamic Panel Data and the HYT Dynamic Panel Data are for the period 2003-2021, being the endogenous variable, respectively, the payments on the VAT yield (PVAT) and the payments on the HYT yield (PHYT) of the fourteen Autonomous Communities, using the *IV* estimator and its generalization by GMM. Data are annual. The transformation in first differences is applied to eliminate the individual fixed effects. The weighting matrix used is a white period (cross-section cluster). The estimated panel includes 238 standard observations. The transformation in first differences is applied to eliminate the individual fixed effects. All variables are in levels. Table 8 provides the variables' definitions and statistical sources. Subsequently, the stationarity analysis is provided.

4.1 UNIT ROOTS ANALYSIS

According to Baltagi (2021), testing for unit roots in panels has been made known by the Levin, Lin, and Chu (2002), *LLC* test, and Im, Pesaran, and Shin (2003), *IPS* test. Both are different if the AR(1) process is considered for a data panel, $Y_{it} = p_i Y_{it-1} + X_{it} \delta_i + \mu_{it}$, where i = 1,2,....,N and t = 1,2,....,Ti, because of *LLC* test assumes cross-section homogeneity, this is, *pi = p* common to all individuals. However, the *IPS* test allows for a heterogeneous coefficient *pi*, which varies between individuals. The IPS*t-bar* statistic is the average of the individual ADF statistic when μ_{it} is serially with different serial correlation properties across cross-sectional units. Eviews performs the LLC, IPS, and Fisher type, test of Madala and Wu (1999) and Choi (2001) using ADF and Phillips-Perron type individual unit root test.

Table 8. Data definition and statistical sources

Variable	*Definition*	*Statistical sources*
FSHYT	Final settlement for Hydrocarbons Tax	Ministry of Finance (2023a)
FSVAT	Final settlement for VAT	Ministry of Finance (2023a)
RDI	Regional Demand Indexes	Ministry of Finance (2023a)
RWDH	Regional Hydrocarbons weighted Demand Indexes	Ministry of Finance (2023a)
CHYT	Liquid collection of Hydrocarbons Tax with regulation	Ministry of Finance (2023a)
CSHYT	Collection of Tax on retail sales of certain hydrocarbons	Ministry of Finance (2023a)
CVAT	Liquid collection of VAT	Ministry of Finance (2023a)
PHYT	Payments on account to HYT Assignment	Ministry of Finance (2023a)
PVAT	Payments on account to VAT Assignment	Ministry of Finance (2023a)
RTR	Regional income tax rate (marginal rate to the regional income average from employment and entrepreneurs).	Ministry of Finance (2023b)
STR	State income tax rate (marginal rate to the regional income average from employment and entrepreneurs).	Income Tax Law

The unit test for VAT panel variables, PVAT, RDI, FSVAT, RTR, and STR, and the unit root test results for HYT panel variables PHYT, RWDH, and FSHYT are performed considering an independent term and the Modified Akaike Information Criterion (MAIC) for automatically selects the maximum number of delays. According to Table 9, the null hypothesis Ho of a common unit root in the data panel is rejected for all the VAT and HYT panel variables in the first and second differences. Besides, the existence of an individual unit root (IPS W-stat, ADF-Fisher, and PP-Fisher) is rejected for all the variables in the VAT and HYT panels in the first and second differences. Consequently, the VAT and HYT panel estimates do not have the spurious regression problem. In addition, variables are cointegrated consistent with the Pedroni test in the VAT panel and HYT panel (not inclued).

4.2 PANEL DATA MODEL

4.2.1. PVAT

The variable $PVAT_{it}$ constitutes payments on account of the VAT yield for the regional government *i* in *t*. It is mainly explained, in addition to the autoregressive of the endogenous variable ($PVAT_{it-1}$), from the regional demand indexes (RDI_{it}) and the final settlement for PVAT ($FSVAT_{it}$). Also, RTR_{it} is used because RDI_{it} varies with income, which depends on regional and State Income Tax rate.

Table 9. Unit root test

Test	First differences	Probability	Second differences	Probability
PVAT				
Ho: common unit root LLC	-15.4994	0.0000	-16.9969	0.0000
Ho: individual unit root process IPS W-st	-12.6116	0.0000	-14.7101	0.0000
ADF-Fisher Chi-square	173.879	0.0000	200.095	0.0000
PP-Fisher Chi-square	401.315	0.0000	707.284	0.0000
RDI				
Ho: common unit root LLC	-5.17469	0.0000	-20.0307	0.0000
Ho: individual unit root process IPS W-st	-3.88504	0.0001	-16.1803	0.0000
ADF-Fisher Chi-square	71.0918	0.0000	221.312	0.0000
PP-Fisher Chi-square	102.324	0.0000	1628.70	0.0000
FSVAT				
Ho: common unit root LLC	-23.4841	0.0000	-25.3760	0.0000
Ho: individual unit root process IPS W-st	-20.3002	0.0000	-26.2615	0.0000
ADF-Fisher Chi-square	278.695	0.0000	365.438	0.0000
PP-Fisher Chi-square	3306.00	0.0000	3687.47	0.0000
RTR				
Ho: common unit root LLC	-11.6816	0.0000	-23.4581	0.0000
Ho: individual unit root process IPS W-st	-10.0443	0.0001	-20.1535	0.0000
ADF-Fisher Chi-square	138.322	0.0000	282.905	0.0000
PP-Fisher Chi-square	143.510	0.0000	1761.43	0.0000
STR				
Ho: common unit root LLC	-13.2025	0.0000	-32.9468	0.0000
Ho: individual unit root				

process IPS W-st	-8.05165	0.0001	-27.0118	0.0000
ADF-Fisher Chi-square	154.551	0.0000	554.711	0.0000
PP-Fisher Chi-square	252.118	0.0000	2537.46	0.0000
PHYT				
Ho: common unit root LLC	-15.1888	0.0000	-28.9928	0.0000
Ho: individual unit root process IPS W-st	-16.7999	0.0000	-27.1478	0.0000
ADF-Fisher Chi-square	231.081	0.0000	387.014	0.0000
PP-Fisher Chi-square	289.737	0.0000	3194.44	0.0000
RWDH				
Ho: common unit root LLC	-75.7198	0.0000	-63.5033	0.0000
Ho: individual unit root process IPS W-st	-26.1000	0.0000	-32.1723	0.0000
ADF-Fisher Chi-square	369.984	0.0000	483.927	0.0000
PP-Fisher Chi-square	380.643	0.0000	1369.28	0.0000
FSHYT				
Ho: common unit root LLC	-22.2604	0.0000	-25.6167	0.0000
Ho: individual unit root process IPS W-st	-18.8645	0.0000	-22.9711	0.0000
ADF-Fisher Chi-square	259.777	0.0000	314.078	0.0000
PP-Fisher Chi-square	1277.49	0.0000	3163.77	0.0000

Subsequently, the panel data model defined to explain $PVAT_{it}$ is,

$$PVAT_{it} = \eta_{1i} + \alpha_1 PVAT_{it-1} + X'_{it}\beta + v_{1it} \quad (1)$$
$$v_{1it} \sim iid\ N(0, \sigma^2)$$

Being X'_{it} a 3 × 1 vector of observations of the explanatory variables (RDI, FSVAT, RTR) in the individual *i* and time *t* and v_{1it} a white noise error term in VAT panel, being i = 1, 2,…,14, the number of individuals considered in the period t = 1, 2,…,19. The term η_{1i} is the term for individual fixed effects in the VAT panel.

Consequently, estimates are for the equation:

$$PVAT_{it} = \eta_{1i} + \alpha_1 PVAT_{it-1} + \beta_1 RDI_{it} + \beta_2 FSVAT_{it} + \beta_3 RTR_{it} + v_{1it} \quad (2)$$
$$v_{1it} \sim iid\ N(0, \sigma^2)$$

Being *i* the notation of the Autonomous Community and *t* the year.

In turn, the sign of the coefficient α_1 is expected to be positive because of $PVAT_{it}$ based on a budgetary forecast of VAT collection for the following year (t), and planned demand indexes. Also, the sign of β_1 is expected to be positive because there is a direct relationship between demand indexes and the collection of VAT. Besides, it is expected to be a positive sign of $\beta_2$because the payments on the account system are resources from the State to Autonomous Communities. Finally, the sign of β_3, as expected, is positive under what suppose a direct relationship exists between direct and indirect tax rates.

Instruments

The GMM estimator uses different instruments for each period, while the instruments related to the periods correspond to delays of the dependent variable and other exogenous variables. The autoregressive of the endogenous variables, $PVAT_{it-2}$, RDI_{it-1}, $CVAT_{it-1}$, and STR_{it}, are considered potential instruments for GMM estimates. Those instrumental variables must be uncorrelated with the perturbation but highly correlated with the explanatory variables. It occurs in $PVAT_{t-2}$ and RDI_{t-1}, which are used as instruments for the periods. Meanwhile, for each period, $CVAT_{it-1}$ is an instrument for $FSVAT_{it}$ because the final settlement of the VAT is in two years. Finally, if the variable RTR_{it} is correlated with the error term, it should be because RTR_{it} is correlated between regions. Moreover, using STR_{it} as an instrument should be justified because the base tax is the same as the State and regional Income Tax.

4.2.2 PHYT

The variable $PHYT_{it}$ constitutes payments for the HYT yield from applying the general and special State rate for the regional government *i* in *t*. It is mainly explained, in addition to the autoregressive of the endogenous variable ($PHYT_{it-1}$), from the regional demand indexes of deliveries of gasoline, diesel, and fuel oils, weighted by the corresponding State tax rates ($RWDH_{it}$), and the final settlement for PHYT ($FSHYT_{it}$). Also, RTR_{it} is used because $RWDI_{it}$ varies with income, which depends on regional and State Income Tax rate.

Subsequently, the panel data model defined to explain $PHYT_{it}$ is,

$$PHYT_{it} = \eta_2 i + \alpha_2 PHYT_{it-1} + X'_{it}\,\beta + v_{2it} \quad (3)$$
$$V_{2it} \sim iid\ N(0, \sigma^2)$$

Being X'_{it} a 3 × 1 vector of observations of the explanatory variables (RWDI, FSHYT, RTR) in the individual *i* and time *t* and v_{2it} a white noise error term in the HYT panel, being i = 1, 2,…,14, the number of individuals considered in the period t = 1, 2,…,19. The term $\eta_2 i$ is the term for individual fixed effects in the panel HYT model.

Consequently, estimates are for the equation:

$$PHYT_{it} = \eta_{2i} + \alpha_2 PHYT_{it-1} + \beta_4 RWDI_{it} + \beta_5 FSVAT_{it} + \beta_6 RTR_{it} + v_{2it} \quad (4)$$
$$v_{2it} \sim iid\ N(0, \sigma^2)$$

Being *i* the notation of the Autonomous Community and *t* the year.

In turn, the sign of the coefficient α_2 is expected to be positive because of PHYTit based on a budgetary forecast of HYT collection for the following year (t), applying the general tax rate, the special

tax rate, and the provisional regional indexes of supplies of petrol, diesel, and fuel oils. Also, the sign of β_4 is expected to be positive because there is a direct relationship between weighted demand indexes and the collection of HYT. Besides, it is expected to be a positive sign of β_5 because the payments on account system are resources from the State to Autonomous Communities. Finally, the sign of β_6, as expected, is positive under what suppose a direct relationship exists between direct and indirect tax rates.

Instruments

The autoregressive of the endogenous variables, $PHYT_{it-2}$, $RWDI_{it-1}$, and variables $CHYT_{it}$ and STR_{it}, are considered potential instruments for GMM estimates. It occurs in $PHYT_{it-2}$ and $RWDI_{it-1}$, which are used as instruments for the periods. Meanwhile, for each period, $CHYT_{it}$ is an instrument for $FSHYT_{it}$ because of in *t* PHYT are from planned HYT collection by the application of the general and special State rate, based on provisional demand indexes of deliveries of gasoline, diesel, and fuel oils, weighted by the corresponding State tax rates. However, the final settlement of the HYT will be in two years. Finally, if the variable RTR_{it} is correlated with the error term, it should be because RTR_{it} is correlated between regions. Moreover, using STR_{it} as an instrument should be justified because the base tax is the same as the State and regional Income Tax.

5 RESULTS AND DISCUSSION

The results of Table 10 show that all the explanatory variables in the data panel for PVAT are significant, according to the t-statistic, at the significance level of 5%. Besides, as expected, the sign of the coefficients α_1, β_1, and β_3 is positive. However, is negative the sign of the coefficient β_2. In addition, Table 10 shows the results of HYT panel estimates; subsequently, all the explanatory variables in the data panel for PHYT are significant, according to the t-statistic, at the significance level of 5%. Besides, the sign of the coefficients α_2, β_4, and β_6, as expected, is positive. However, it is negative the sign of the coefficient β_5.

In estimating GMM by IV, besides the parameter estimates, it is essential to contrast the validity of the instrumental variables by performing the Arellano and Bond test to determine the lack of serial correlation. The test is two separate statistics, one for first order correlation (m_1) and one for the second (m_2). The m_2 statistic contrasts the absence of second-order serial correlation, AR (2), in the residues from the equation in the first difference. It occurs if the error term in the level model is not correlated and if the error term has a unit root. If the innovations are i.i.d., the first-order statistic must be expected to be significant (with a negative auto-correlation coefficient) and the second-order statistic to be insignificant. Following, the J statistic, or value of the objective function GMM in the value of the estimated parameters, is used to contrast the null hypothesis of over-identification of the restrictions or the Sargan test.

According to Table 11, for the PVAT equation, at the confidence level of 5%, the first-order statistic m_1 is significant. Therefore, the hypothesis of non-correlation in the first-order autoregressive AR(1) is accepted, while the m_2 statistic is not significant. Moreover, the null hypothesis of overidentification of restrictions is rejected according to statistic J of 155,6283 (*p-value*: 0,277481). Also, for the PHYT equation, at the confidence level of 5%, the hypothesis of non-correlation in the first-order autoregressive AR(1) is accepted, while the m_2 statistic is not significant. Moreover, the null hypothesis of overidentification of restrictions is rejected according to statistic J of 11,98527 (*p-value*: 0,286043). Consequently, the validity of the instrumental variables in the VAT panel and HYT estimates are contrasted enough.

Therefore, the main results of this study were that the regional tax on income rate (RTR) also influences the collection of the assignments of VAT and HYT, which are the main taxes of the AFS's basic taxation, joining the regional Income Tax. Because the signs of the variable FSVAT and FSHYT were opposite to the expected, it suggests that it occurs because RTR influences VAT and HYT collection. Subsequently, some inefficiencies arose regarding collecting the VAT and HYT assignments through the AFS's payments.

Table 10. Panel Generalized Method of Moments

Dependent variable: PVAT			
Instrument specification: ***@DYN PVAT(-2), RDI(-1), CVAT(-1), STR; constant added***			
Variable	**Coefficient**	**t-statistic**	**p-value**
PVAT(-1)	0,614517	9,710390	0,0000
RDI	379493,5	4,212571	0,0010
FSVAT	-0,456112	-8,824738	0,0000
RTR	117577,8	2,985898	0,0105
Dependent variable: PHYT			
Instrument specification: ***@DYN PHYT(-2), RWDH(-1), CHYT, STR; constant added***			
Variable	**Coefficient**	**t-statistic**	**p-value**
PHYT(-1)	0,667835	19,19533	0,0000
RWDH	15409,47	6,159564	0,0000
FSHYT	-0,252628	-15,32911	0,0000
RTR	18068,27	11,72527	0,0000

Table 11. Arellano-Bond Serial Correlación Test

Dependent variable: PVAT			
Test Order	**m-statistic**	**Rho**	**p-value**
AR(1)	-7,654899	-42786530	0,0000
AR(2)	0,785059	471695399	0,4324
Dependent variable: PHYT			
Test Order	**m-statistic**	**Rho**	**p-value**
AR(1)	-2,984551	-73807522	0,0028
AR(2)	1,752964	304867321	0,0796

As a result, RTR influences VAT collection; inefficiencies could be justified as a horizontal externality because RTR shows some correlation between Autonomous Communities; it affects redistribution between them. Consequently, State transfers must internalize such horizontal externalities.

Nowadays, remote sales to other countries threaten the VAT base. In this case, State transfers cannot internalize such externalities from another country, and the tax capacity of the actual AFS is damaged. Regarding HYT collection inefficiencies refer first to a vertical externality because HYT has been applied at an autonomic rate and State rate on the same base for 2002-2018. Besides, RTR influences HYT collection and affects regional government redistribution. Accordingly, State transfers must internalize such vertical and horizontal externalities.

However, outside of the AFS, there is a devolution regime for the professional use of hydrocarbons and gasoil use by agriculture and farmers, which the regional government set a tax rate for the gas oil devolutions. Nowadays, the AEAT must refund collection from the autonomic tax rate for 2013-2018 to entrepreneurs. Nevertheless, VAT on hydrocarbon fraud plots or transport strikes in 2022 show that such externalities are not internalized enough. Subsequently, those indirect taxes affect essential economic activities, these results are relevant enough.

6 CONCLUSIONS

This work studies possible inefficiencies concerning the VAT and the HYT collection by regional governments in Spain through the payment system by estimating dynamic panel data using IV and its generalization by GMM. Estimates results are so significant, although the sign of the coefficient $\beta 2$ and coefficient $\beta 5$ are opposite to the expected. Besides, the validity of the instrumental variables is also in contrast. However, all variables are defined in levels; subsequently, elasticities are not provided. The main results of this study were that the regional tax on income rate (RTR) also influences the collection of harmonized taxes VAT and HYT, which constitute the main taxes of the AFS's basic taxation. Consequently, some inefficiencies arose regarding the collection of these taxes.

Several authors point out that the co-occupancy of tax bases also arises concerning the provision of public services; otherwise, general transfers of the AFS aim to correct such externalities. Regarding VAT horizontal externality, the regional income tax rate shows some correlation between Autonomous Communities and influences VAT collection. Externalities arise because they affect redistribution between them. State transfers internalize such horizontal externalities. However, such transfers cannot counter the erosion of the VAT base and, consequently, tax competition from other EU countries.

Vertical and horizontal externalities arise from collecting HYT through the payments on account system, which State transfers should internalize. It occurs because, for the period 2002-2018, there was an overlap of bases because of the autonomic tax rate. Besides, RTR influences HYT collection. Externalities outside of the AFS should be corrected by lowering the tax rate, which was the autonomic rate currently at the state rate because they affect essential economic activities. Otherwise, the AFS is under review; future work must analyze if such inefficiencies about VAT and HYT are corrected.

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