Applied Journal of Economics, Law and Governance https://doi.org/10.57017/ajelg.v2.i1(3).09

Fiscal Incentive Design and Digital Governance: A Time-Series Analysis of Tax Compliance in Southern Brazil

Jorge Luis TONETTO ✉
https://orcid.org/0000-0002-9704-6894
La Salle, Universitat Ramon Llull, Barcelona, Spain

Josep Miquel PIQUE ✉
https://orcid.org/0000-0002-0215-0139
La Salle, Universitat Ramon Llull, Barcelona, Spain

Adelar FOCHEZATTO ✉
https://orcid.org/0000-0001-7192-3986
Pontifícia Universidade Católica do Rio Grande do Sul, Brazil

Carina RAPETTI ✉
https://orcid.org/0000-0001-6423-7478
La Salle, Universitat Ramon Llull, Barcelona, Spain

Abstract

The state of Rio Grande do Sul, Brazil, implemented four behavioural experiments aimed at improving tax compliance. This study contributes to the literature by examining multiple behavioural tax programs, providing a longitudinal assessment of citizen engagement. It highlights changes in citizen engagement in the Tax Education Program, focusing on the evolution of new subscribers and their relationship with the implementation of innovative projects. We estimate time-series regression models for new subscribers between November 2012 and May 2023, including specifications with and without structural breaks. The key moment corresponds to the launch of Devolve-ICMS and Receita Certa, with a 635% increase in new subscribers. Inflation showed a small negative impact. The results suggest that reductions in the value of rewards and low-value incentives negatively affected engagement, while initiatives providing direct and visible financial returns to citizens, reinforcing perceptions of fairness and reciprocity, had particularly strong effects on engagement.

Keywords: behavioural economics, fiscal citizenship, digital government, information asymmetry, law enforcement, technological change.

JEL Classification: D91; H26; H11; C22; K42; O33.

Introduction

The primary objective of tax education programs is to promote fiscal awareness and strengthen citizenship through the dissemination of tax-related knowledge. Such programs play a key role in fostering cultural and behavioural change among taxpayers (Souza and Souza, 2018). The evolution of the Fiscal Citizenship Program in Rio Grande do Sul (RS) since the 1980s reflects a strategic effort to improve tax compliance and reduce tax evasion. Initially, the program encouraged consumers to collect and exchange invoices for coupons that granted

access to prize draws. This mechanism enabled tax authorities to cross-check the tax declarations submitted by commercial establishments against actual economic transactions, thereby improving fiscal oversight and revenue collection.

The core principle of the program remains unchanged: encouraging citizens to include their taxpayer identification number (CPF) in the electronic fiscal documents of their purchases at participating establishments. Today, several new projects are used to stimulates taxpayers to request invoices. Some projects are based on rewards, others on cashback, and even on helping citizens search for the best prices for products. The Gaúcha[1] Invoice Program (NFG) allows citizens to accumulate points when they include their tax identification (CPF) number in the fiscal documents of their purchases at participating establishments. In 2023, the program had already reached 3.5 million people, corresponding to almost one-third of the state's population. According to Mazzucato (2021), in a critique of the neoclassical vision where the role of governments is limited to reactively resolving market imperfections, the government must act to structure new markets with the aim of delivering to society the results it desires.

Therefore, the government must be concerned about its own financing. Among the alternatives to guarantee sources of financing is tax education, which enables greater taxpayer engagement and more resources, and also contributes to a fair market without evasion. In the context of Brazilian tax authorities, the tax administration of Rio Grande do Sul is an innovative major player, and the NFG projects launched are examples of processes that create value for citizens. According to Alm (2012), a lot has been learned, but there are still many gaps in our understanding of tax evasion. Tax evasion remains an important problem in many countries, both developed and, even more so, in developing countries. (Buehn & Schneider, 2016; Cebula & Feige, 2012; Gamannossi degl'Innocenti & Rablen, 2020; Slemrod, 2007). Slemrod (2024) emphasizes that tax economics should recognize the substantial role of behavioural anomalies in explaining tax evasion.

The challenges in tax administration in countries like Brazil, where indirect tax is broadly used, occur in a context of informality and significant tax gap. In this article we describe four new projects that seek to increase the engagement of Rio Grande do Sul society in combating tax evasion. The projects are related to tax education and need to be understood considering behavioural economics and neuroeconomics.

We seek to deepen the behavioural understanding of citizens as taxpayers and their motivation, whether through the influence of social norms, notions of fairness, prizes or games, cashback, or even instant rewards. We aim to analyse whether the tax innovations implemented in RS are increasing taxpayer engagement. To identify this change, the structural break model was used. Behavioural economics helps to understand possible distinct outcomes of projects, as well as their context and applicability.

Despite numerous studies on behavioural interventions and tax incentives, significant gaps remain in the empirical literature. Most existing research relies on laboratory experiments, short-term field interventions, or cross-sectional data, limiting our understanding of how behavioural responses evolve over time and under real-world public policy conditions. In particular, there is limited evidence on the long-term behavioural effects of tax incentives, the impact of changes in incentive design, and the role of digital tools in shaping citizen

[1] 'Gaúcha' refers to belonging to the state of Rio Grande do Sul.

participation in tax-related programs. Furthermore, few studies employ time-series methods that allow for the identification of structural changes associated with policy interventions.

This study contributes to the literature by providing long-term time-series evidence on behavioural responses to tax incentives and digital tools, using administrative data from a large-scale public policy implemented in Southern Brazil. Specifically, we estimate regression models with and without structural breaks to assess the behavioural impact of policy changes in program value magnitude and incentive structures, the introduction of cashback mechanisms and instant rewards, and the implementation of a mobile price information application. By analysing more than ten years of monthly data, this study offers new evidence on how incentive design and digital engagement tools influence citizen behaviour in a real-world policy environment.

This approach enables us to identify how different types of behavioural incentives and policy changes affect citizen engagement over time, thereby contributing to the literature on behavioural public economics, incentive design, and digital government. In particular, it highlights the multifaceted behavioural dimensions through which incentives operate.

In addition to this introduction, this article consists of Section 2 which presents a review of the literature on behavioural economics focusing on the main topics related to the fiscal education projects. Section 3 describes the four NFG projects, how they work, and their specific results. The section 4 describes the methodological procedures used in the study. Section 5 presents and discusses the results obtained. The final section presents the study's conclusions and recommendations for public policy.

1. Literature Review on Behavioural Economics

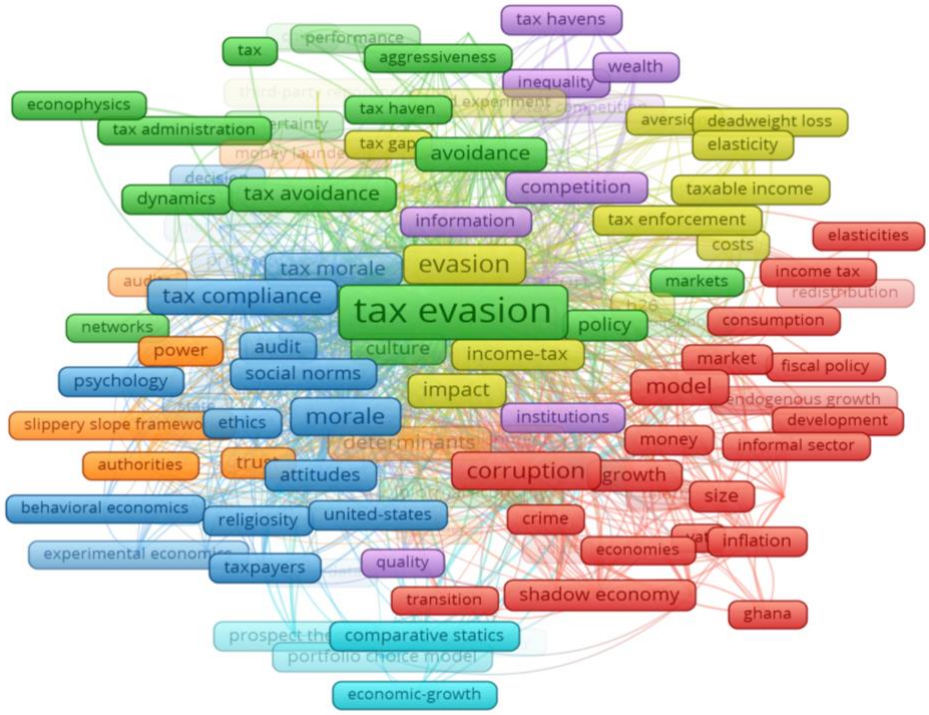
Behavioural Economics (BE) is a field of research that combines economics with scientific disciplines such as psychology, neuroscience, and other human and social sciences, in addition to empirical discoveries. It challenges the concept of purely rational decision-making by introducing real-life factors that more precisely define human behaviour. Some authors define BE as the study of cognitive, social and emotional influences on economic behaviour (Samson, 2014). This field primarily employs experimentation to develop theories about human decision making (Ávila & Bianchi, 2015; Samson, 2014). Applying this method in the social sciences initially faced opposition from scholars such as Milton Friedman; despite this, BE and its research methodologies have gradually developed and gained academic recognition (Ávila & Bianchi, 2015).

Figure 1 show the main connections of tax evasion and other concepts. Some concepts of behavioural economics are present, but very few related to neuroeconomics are included. Figure 1 reveals a clear cluster structure in the tax evasion literature, with the green cluster emerging as the primary and most central thematic core. This cluster contains the term tax evasion itself, along with closely related concepts such as tax avoidance and tax administration, indicating that the central focus of the literature lies in the administrative dimensions of tax compliance. The proximity and density of these connections suggest that tax evasion is predominantly studied as a function of tax system design, administrative capacity, and regulatory structure. This cluster reflects the traditional public finance approach, in which evasion is analysed in relation to enforcement mechanisms, legal frameworks, and compliance processes.

The second most prominent cluster (in red) represents the macroeconomic and institutional environment in which tax evasion occurs. It includes terms such as corruption, shadow economy, institutions, crime, inflation, fiscal policy, development, and economics. Its strong connection with the central green cluster indicates that tax evasion is closely associated with institutional quality and broader structural conditions. The presence of the model node within this cluster further highlights the importance of formal economic modelling in explaining evasion behaviour, particularly in relation to corruption, informality, and weak institutional enforcement. This cluster situates tax evasion within a systemic context, emphasizing that evasion is not merely an individual decision but also a structural outcome shaped by institutional credibility, economic conditions, and governance effectiveness.

The behavioural and psychological dimension appears primarily in the dark blue cluster, which includes terms such as behavioural economics, psychology, social norms, morale, and ethics. This cluster occupies a strategically connected position, indicating that behavioural factors are widely recognized as significant. However, behavioural concepts do not operate in isolation; rather, they span across clusters. Overall, the network suggests that behavioural economics functions as a cross-cutting explanatory layer, influencing tax evasion through psychological mechanisms that interact with institutional quality, enforcement, and economic conditions, rather than replacing these structural determinants.

Figure 1: Map clusters of Tax Evasion subject



Source: Search in WoS, from Jan 2010 to May 2024, based on 500 articles. Compiled by the authors.

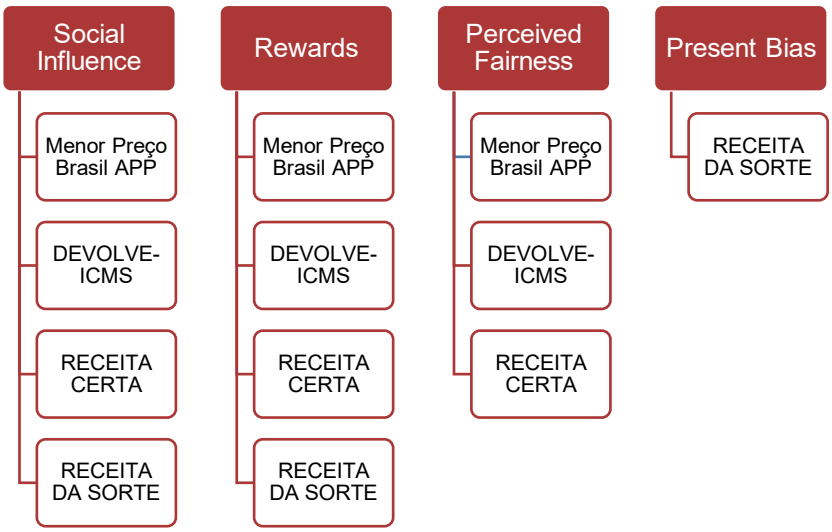
Kahneman & Tversky (1979) present prospect theory, showing how people's preferences are influenced by different probability representations, including the attraction of low odds in insurance and gambling. This research area identifies three significant deviations from the standard model: (1) nonstandard preferences, (2) nonstandard beliefs, and (3) nonstandard decision making. Empirical evidence supports these deviations in several applications, ranging from consumption to finance, and from crime to voting (DellaVigna, 2009).

In BE, decisions are shaped by habits, experiences, and heuristic rules. Satisfactory solutions are accepted, rather than maximization ones. It recognizes that it is difficult to reconcile short and long-term interests and that decisions are strongly influenced by emotional factors and interactions with other decision makers (Ávila & Bianchi 2015). It is necessary to emphasize that the relationship between taxpayers and tax authorities is naturally imbued with risk aversion, which can be mitigated by the degree of transparency established in the relationships.

The literature overview is restricted to the concepts identified as possible reasons for the findings in the case studies described in the previous section. The four concepts used are social influence, rewards, perceived fairness and present bias. These concepts are illustrated in Figure 2 combined with the four tax education projects. Social Influence (and norms) refer to how tax and economic decisions are shaped by social expectations, including descriptive norms (what others do) and injunctive norms (what others approve), as well as the perceived level of compliance among peers. Perceived fairness refers to taxpayers' subjective evaluation of the fairness of the tax system, including the distribution of tax burdens, or spending and the procedures used by authorities. Present bias refers to the tendency of individuals to overweight immediate costs and benefits relative to future ones, potentially leading taxpayers to undervalue future penalties or delayed rewards.

Rewards also include punishments and refer to how tax compliance decisions are shaped by the perceived expected costs of evasion, including the probability of detection and penalty severity, as well as by positive incentives such as monetary prizes, tax cashback mechanisms, and fiscal lottery programs, which increase the perceived benefits of compliant behaviour and formal participation in the tax system.

Figure 2: Tax Compliance Projects and BE Concepts



Source: Compiled by the authors.

All four RS projects should have the ability to influence the taxpayers and their social circle in various ways, some more than others. They also offer rewards and benefits ranging from discovering where to purchase the desired product at the nearest location for the lowest price to direct monetary rewards through lotteries or cashback. Many of these projects operate on the principle of fairness or justice, particularly with Devolve-ICMS. This concept is also evident in Receita Certa through large-scale cashback implementation and in the app which shares information about taxpayers who participate in the NFG. The Receita Certa emphasizes

instant prizes and the anticipation and excitement associated with them. Table 1 shows the monthly average of citizen beneficiaries. This allowing us to observe the wide scope of Devolve-ICMS and Receita Certa. The Menor Preço Brazil project in 2022 had a monthly average of 1.7 million queries on the app.

Table 1: Projects and average beneficiaries from Jan 2021 to May 2023.

Projects	Average Citizens Beneficiaries	Criterion
Monthly prize	869	Monthly
Receita da Sorte	723	Monthly
Receita Certa	666,880	Quarterly
Devolve-ICMS	545,642	Quarterly

Source: SEFAZ/RS. Compiled by the authors. Note: Receita Certa is calculated by effective prize redeem, from Apr 2021 to Mar 2022 (4 cashbacks).

Regarding social influence and norms, the discussion focuses on how decisions in behavioural economics are influenced by habits, experiences, heuristic rules, and social preferences. Satisfactory solutions are accepted rather than maximization. There is recognition of the difficulty in reconciling short- and long-term interests, which are influenced by emotional factors and interactions with other decision-makers. (Ávila & Bianchi, 2015). Attitudes toward taxation and government are shaped in a social context and influence taxpayer behaviour. Factors such as perceived fairness, stability of tax structures, complexity, and the value attributed to government actions affect intentions and behaviour (Bird, 2010). According to Tonetto (2026), public policy outcomes are sensitive to national and regional contexts, particularly social and cultural conditions.

Alm et al. (2023) emphasize that audits and fines remain central to tax compliance but argue that complementary behavioural interventions are also necessary. Their findings show that nudges have mixed effects, with effectiveness depending on their design and communication by the tax administration. They conclude that behavioural tools can complement traditional deterrence policies but require careful design and empirical evaluation before implementation. According to Carvalho et al. (2023), behavioural models of tax evasion have expanded significantly, particularly following the creation of nudge units inspired by experiences in the US and the UK. To address criticisms related to paternalism, short-term bias, and fragmentation, the authors propose the Nested Circles Model, which situates taxpayer behaviour within interconnected microworld, midstream, and upstream influences. The model emphasizes intangible determinants such as social trust, perceived fairness, and the quality of the relationship between taxpayers and authorities. It also highlights temporal reward dynamics, recognizing that long-term responses may differ from short-term effects. Furthermore, tax systems are understood as networks of heterogeneous social actors, each operating with limited information and bounded interests.

With respect to compliance with tax obligations, an experiment carried out by the government of the state of Minnesota, USA, showed that when people receive information that compliance with the law is high, they become less likely to evade taxes (Sunstein & Thaler, 2019). The study highlights that misperceptions about other taxpayers' tax compliance can have a negative effect. Research findings indicate that feedback can correct this perception and increase compliance (Wenzel, 2005).

From the perspective of perception of justice or perceived fairness, lotteries distribute benefits and costs across the population. The effectiveness of lottery tickets in improving tax compliance depends on socioeconomic factors (Fabbri, 2015). Evidence from Tonetto et al. (2025) shows that instant lottery incentives implemented through a smartphone app can generate behavioural responses consistent with addiction and herd effects.

There is discussion about the negative perception of sanctions for not asking for an invoice, which can lead to resentment and criticism. The authors suggest that incentives should be aligned with public cooperation rather than enforcement (Fabbri & Hemels, 2013). Tax morale in countries that emerged from communist rule is affected by trust, measured as confidence in government institutions, and greater satisfaction with the political system leads to higher tax morale (Torgler, 2004).

For some authors, there is a psychological contract in regarding taxes that shapes morality, which arises from a complicated relationship between taxpayers and the government. Compliance tends to increase if the political process is perceived as fair and legitimate, even if there is no equivalence between the amount paid in taxes and the public goods received (Feld & Frey, 2006). According to the World Bank (2025), compliance with tax obligations is often hindered by a range of behavioural and psychological barriers. These include limited knowledge of tax obligations, ineffective communication, the perception that others do not comply, the complexity of calculating and making payments, procrastination between intention and action, a lack of timely reminders, the belief that the risk of punishment is low, and dissatisfaction with public services, among others. Whether operating individually or collectively, these barriers undermine both the capacity and the motivation of taxpayers to meet their tax obligations.

Regarding the influence of present bias, or time discounting, studies on individual risk preferences in China using monetary incentives demonstrate their impact on revealed risk preferences. The influence of rewards and punishments is linked to various aspects of behaviour (Kachelmeier & Shehata, 1992). The timing and type of rewards in two service conditions (satisfied vs. dissatisfied) show that when consumers are dissatisfied, they prefer immediate and direct rewards over delayed ones, while the opposite is true when they are satisfied (Keh & Lee, 2006). It is also worth noting that sales promotions in monetary terms are preferable to those in non-monetary terms, and the instant receipt of rewards is preferable to delayed receipt (Gautam, 2012).

The analysis of the effects of monetary incentives on individual effort and task performance suggests that, depending on the context in which they are applied, they can lead to either an increase or a decrease in effort (Bonner & Sprinkle, 2002). Analysis of behavioural interventions to increase tax compliance observed that the effectiveness of rewards and punishments is influenced by contextual aspects and individual motivations. The failure of tax lotteries in Georgia suggests that incentives should strengthen positive reciprocal relationships with government authorities rather than reinforcing uncomfortable relationships (Björklund Larsen, 2023). The general consensus is that monetary incentives lead to greater effort than would otherwise occur. However, some authors argue that monetary incentives can lead to decreased effort and performance. Research supports this idea by showing that monetary rewards decrease people's intrinsic motivation and that there is less intrinsic motivation in people who are paid for an activity (Deci & Ryan, 1985). It is worth noting that in tax lottery programs there is an increase in their intrinsic value because their cost is zero, benefitting from the extra power of free goods (Shampanier et al., 2007).

Outside the economic field, research has highlighted the biological foundations of behaviour and rewards, particularly the role of dopamine in motivation, reinforcement, and reward processing (Becker et al., 2013; Purves et al., 2018; Kandel et al., 2000; Zald et al., 2004). Genetic studies further suggest that dopamine regulation influences risk-taking and time preferences, linking dopaminergic mechanisms to impulsive and sensation-seeking behaviours (Carpenter et al., 2011). Behavioural evidence also indicates gender differences in reward processing (Hahn et al., 2021). Neuroimaging studies have likewise demonstrated that emotions and reward expectations shape economic decision-making (Sanfey et al., 2003), while choices involving immediate rewards are associated with activity in regions connected to the dopamine system, whereas delayed rewards are linked to greater frontoparietal activity (McClure et al., 2004).

Tax compliance has become a key issue for tax administrations worldwide. To better understand taxpayer heterogeneity, Paleka & Vitezić (2023) analysed taxpayers' perceptions and attitudes and identified four distinct profiles: "Extrinsically Motivated," "Morally Committed," "Financially Motivated," and "Socially Committed" taxpayers. The first and third profiles were primarily influenced by economic factors, whereas the second and fourth were largely driven by psychological determinants. These findings highlight the importance of designing policies that encourage voluntary tax compliance while imposing minimal costs on the tax system. The results are similar and consistent with Torgler's (2003) taxpayer typology and suggest that different taxpayer profiles may respond differently to policy interventions. Consequently, recognizing these differences offers a practical basis for tailoring tax strategies to specific segments of the taxpayer population.

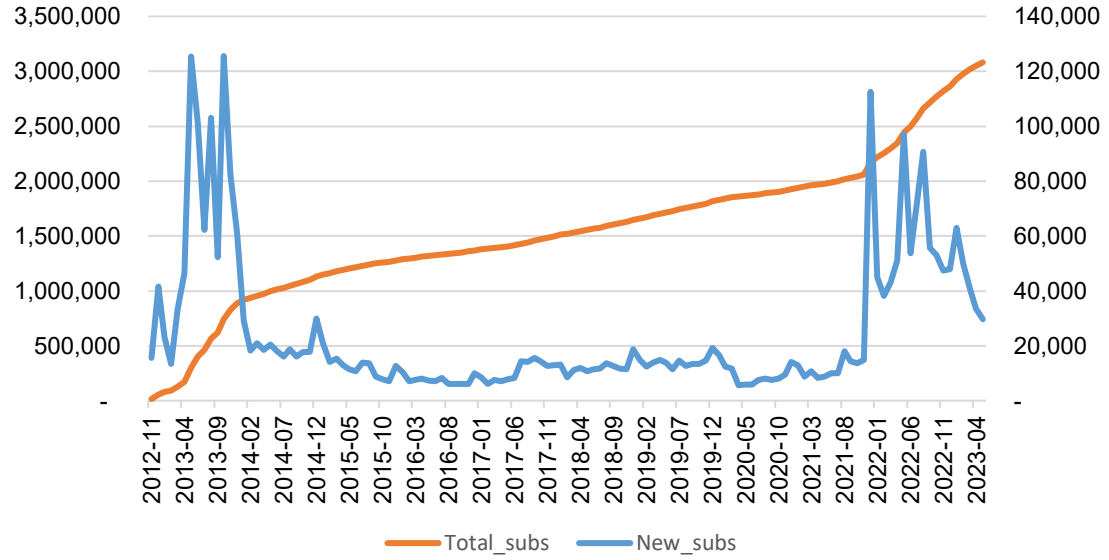
Beyond individual motivations, institutional characteristics of the tax system also influence compliance behaviour. An analysis of 46,000 firms across 83 countries indicates that greater tax complexity is associated with higher levels of tax evasion, while longer compliance procedures and higher tax burdens increase both the magnitude and incidence of non-compliance (Saptono et al., 2024). These findings suggest that improving compliance requires not only enforcement mechanisms and behavioural incentives, but also simpler and more accessible tax systems that reduce informational and administrative barriers faced by taxpayers. Alm (2021) argues that technological advances and the digitalization of information tend to strengthen governments' ability to reduce tax evasion. However, technology also creates new opportunities for evasion, making its long-term effects uncertain. The author suggests that tax evasion will become more difficult for most taxpayers and concludes that technological change is likely to increase economic inequality.

2. Description of Tax Compliance Projects

Rio Grande do Sul's tax authorities have a longstanding tradition of promoting tax education. The fiscal citizenship program in the state dates back to the 1980s, initially aiming to boost tax collection by encouraging citizens to exchange invoices for coupons and participate in prize draws. Over time, additional initiatives were introduced, focusing on fiscal education and enhancing public understanding of how tax revenues are allocated, particularly regarding public expenditures. These efforts extended the principle of transparency beyond mere publicity, striving to provide citizens with a comprehensive understanding of the tax system. The RS tax administration operates based on the model of the tax compliance pyramid. This has shifted the administration towards a more citizen-centric model, reserving punitive action as a last resort (Tonetto et al., 2024b).

The current program was launched at the end of 2012 with monthly prize draws and experienced rapid growth in its initial years, reaching 1 million registered users by June 2014. From 2015 to 2018, the rate of new registrations stabilized, averaging 10,755 new participants per month, significantly lower than the earlier period, which saw over 40,000 monthly sign-ups. As shown in Figure 3, citizen participation in the program continued to grow gradually until the end of 2022, when the pace of registrations began to accelerate once again.

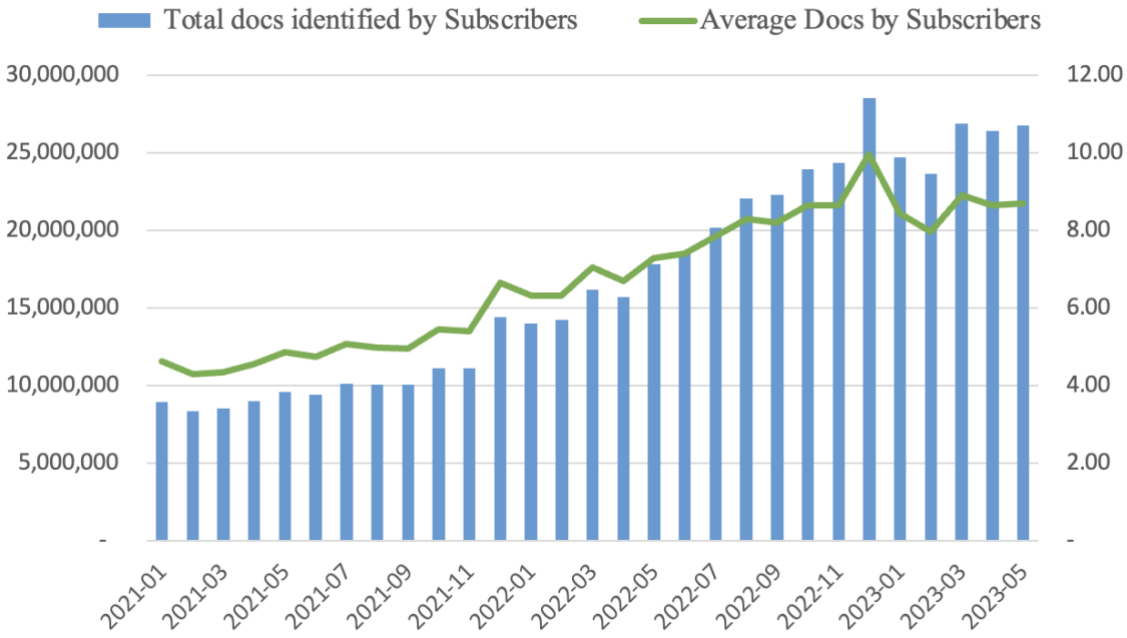
Figure 3: NFG Participants and New Monthly Subscribers (Nov 2012–Dec 2022).



Source: SEFAZ/RS. Compiled by the authors.

Within this context, in 2019 several new projects were implemented. Regarding the number of tax documents issued with CPF by participants in the NFG program, the number has grown from 9 million to 26 million of documents. The average number of documents issued per subscriber increased from 4.6 to almost 9 (Figure 4).

Figure 4: NFG Subscriber Invoices and Average Monthly Documents (Jan 2021–May 2023)



Source: SEFAZ/RS. Compiled by the authors.

Next, we outline the four projects that were implemented and evaluated. The impact studies of the Devolve, Receita Certa and Receita da Sorte projects are based on the digital invoices. They all used the difference-in-differences method to determine their impacts. The broad database enabled the use of the DID model, which is the most widely used method to assess the impacts of social projects. This method attributes to the intervention any difference in trends between the treatment and control groups that occur from the time the intervention begins (Gertler et al. 2018). The Menor Preço Brazil app was evaluated using the same methodology as this article, applying structural breaks analysis.

3.1. Menor Preço Brasil App

At the beginning of 2019, the Rio Grande do Sul tax authority developed the Menor Preço application to assist citizens in finding the lowest product prices among more than 300,000 establishments located in the Rio Grande do Sul (RS). The app leverages real-time data from electronic invoices and uses the user's location to display prices and nearby stores, helping users save money and reduce unnecessary travel. The app's main features include filtering results by distance, viewing product prices, points of sale, invoice issuing times and contact information for the store. It also provides price history for the last seven days and includes navigation to selected locations. The default search range is 5 km, which can be extended to 30 km.

In late 2019, the National Council for Finance Policy (CONFAZ), in collaboration with Brazil's federative units, approved the development of the Menor Preço Brazil application, based on the Rio Grande do Sul model. Launched in December 2019, the app had recorded more than 44 million searches by 2022 (Tonetto et al., 2023b). To use the App, it was initially mandatory for the user to identify themselves, and after logging in, they were able to search for prices in the database. However, this requirement led to a temporary decline in use due to privacy concerns. It is important to note that only invoices associated with a CPF are included in the database, protecting the buyer's confidentiality. Unidentified invoices are not part of the app's search database. Its operation is based on citizen collaboration. Tax compliance increases because the App encourages citizens to include their individual tax registration number (CPF) on invoices issued, thereby expanding the database.

In response to the COVID-19 pandemic, a special version of the app was launched in March 2020, allowing users to access it without CPF registration to help them locate protective items. During the pandemic, app usage surged, peaking in August 2020 with 2.57 million queries. When the mandatory CPF login was reinstated in November 2020, usage temporarily declined. Over time, however, trust in the app grew, leading to a recovery in usage, with an average of 1.7 million queries per month in 2022.

Regression models revealed significant correlations between app usage, COVID-19 cases, and inflation. The results indicate that a 1% increase in COVID-19 cases resulted in a 0.2% increase in consultations, while a 1% increase in inflation led to an 8.6% increase in the use of the application (Tonetto et al., 2023b). The case study highlights the importance of digital services during crises, illustrating how user trust and the perceived benefits of an application- in this case, savings on purchases and reduced risk of contagion, helped to overcome initial concerns about privacy. As time passed and confidence in the app's service increased, risk aversion decreased.

In the context of the Covid-19 pandemic, the perception of the advantages of using the app, such as saving time and money, as well as the reduced chances of contagion due to the reduced need for unnecessary travel, contributed to its greater use and dissemination in society. It is possible that herd behaviour occurred, as outlined by Sunstein & Thaler (2019). Time also helped to strengthen the understanding that using the app would not imply a greater risk of tax audits or invasions of privacy.

The Menor Preço Brazil App combines the use of multiple structural breaks (Bai & Perron, 1998), with a time-series analysis. The results indicate five structural breaks in the number of queries to the application. This confirms that user behaviour related to the Menor Preço Brasil application was influenced not only by changes in the number of confirmed COVID-19 cases but also by modifications in the app's features related to identified login and inflation rates. The literature also tends to consider the relevance of the relative effects of risk aversion on behaviour, especially in the relationship with the tax authorities. This analysis reinforces the initial relevance of risk aversion and when trust gradually strengthening the aversion to losses diminishes.

3.2. Devolve-ICMS, refund to tax consumption

Consumption taxation is widely used in countries today, due to its collection capacity, which is characterized by fiscal anesthesia and regressivity. This creates a proportionally heavier tax burden on low-income families. To correct or alleviate these characteristics, the state of Rio Grande do Sul implemented the Devolve-ICMS project in November 2021. The project reimburses eligible families for part or all of their ICMS consumption taxes on a quarterly basis.

The refund has a fixed portion and a variable portion, which depends on the inclusion of the taxpayer's tax identification number at the time of purchase. By including their identification number on the invoice, the taxpayer exercises their fiscal citizenship, contributes to fair competition, and increases the variable portion of the tax that will be refunded. This represents the first known application of tax personalization using NFEs to quantify beneficiary family consumption and serve as the basis for refunds (Tonetto et al., 2023a).

The initiative targets families with a monthly per capita income of less than half the national minimum wage or a total household income of up to three minimum wages.

Citizens eligible for this benefit must reside in Rio Grande do Sul, have an active CPF and meet specific criteria, such as being a Bolsa Família beneficiary or having a family member enrolled in a state public high school. Refunds are issued via a Citizen Debit Card, which can be used at over 140,000 establishments across the state. In its first phase, beginning in November 2021, the project provided quarterly payments of R$100.00 to 432,000 families. By July 2022, it expanded to 527,000 families, introducing variable refunds based on documented expenses tied to the taxpayer's CPF. By the end of 2024, the project had reached 665,420 families. The phased implementation is a highlight of the project, allowing for an understanding of the challenges involved in reaching a more vulnerable audience. Beneficiaries of the project are not required to register for the NFG program.

The Project aims to change the taxpayer's behaviour through monetary incentives. The Devolve-ICMS focuses on two aspects: mitigating the repressiveness of the consumption tax, as demonstrated by Tonetto et al. (2023a), and engaging citizens in requesting invoices. It raised the issuance by 0.43 documents in which on average represents a 40% improvement. This project's main scope is tax justice. The literature on behavioural economics supports the

method. It is worth noting that the two axes are recognized in terms of the behaviour change matrix, namely awareness and willingness, the first stimulated by education and the second by rewards (Fehr et al., 2015). As Brazil's first experience with consumption tax personalization, the project represents an innovative model that has begun gaining traction in academic and policy discussions. The 2023 Brazilian tax reform included the idea in the form of a nationwide cashback.

A World Bank study on the Devolve-ICMS project highlights that 60% of eligible families receive only the fixed benefit, and that beneficiary engagement is heterogeneous. Households headed by women demonstrate higher levels of participation in the project, greater registration of formal consumption and more frequent participation in the VAT lottery. The study also finds that participation in the VAT lottery is associated with significantly higher levels of formal consumption, suggesting complementarity between these instruments in promoting formalization (Bachas et al., 2025). A study on the Greek tax lottery, which promotes the use of electronic payments in place of cash by awarding €1,000 to 1,000 winners each month, finds that the lottery disproportionately benefits high-income taxpayers and those with higher levels of spending. The study also shows that self-employed individuals with high spending levels reduced their electronic transactions by half after winning, suggesting that the experience increased their perception of transaction visibility to the tax authority (Nicolaides, 2024).

3.3. Receita Certa, a cashback based on retail revenue

The Receita Certa Project distributes cashback to participants of the Nota Fiscal Gaúcha Program (NFG). Unlike other projects, it does not rely on a lottery system; instead, rewards are given based on the real increase in ICMS (Tax on the Circulation of Goods and Services) collection from retail trade. Every quarter, Receita Certa refunds the tax to taxpayers based on their engagement, the values of their invoices and the condition that the state's revenue grew above inflation. Depending on the level at which revenue exceeds inflation, more or less tax will be returned. If there is no real increase, there will be no refund. Taxpayers accumulate points by adding a CPF to their invoices during purchases, with R$1.00 being equivalent to one point. There are limits to the accumulation of points: a maximum of 1,000 points per tax document, 5,000 points per month per citizen and a maximum of 30 invoices per month from the same establishment (Tonetto et al., 2024a).

The first distribution of rewards took place in December 2021. Subsequent distributions occurred quarterly until May 2023, with one quarter without distribution due to unmet collection conditions. Citizens must request their refund through the NFG app or website, which will be credited directly to their account. The period to request the refund is 90 days. The Receita Certa Project had an initial impact, which was not sustained. The project faces several challenges. Its design has problems, such as the frequent failure to meet revenue growth targets in many quarters, which leads to the discontinuation of recurring refunds; and low cashback redemption rates, possibly due to small reward amounts; and insufficient promotion in the media. The uncertainty of benefits and the quarterly distribution period may also contribute to disengagement.

A positive outcome is the migration of taxpayers to the NFG program, increasing interaction with tax authorities. There is evidence that people who already used to add their tax identification to their invoices but those were not enrolled in the NFG program have signed up en masse to obtain the benefits. This is strongly positive for greater interaction with taxpayers. However, the funds allocated to the project may not justify the results, as many

rewards are not collected, similar to the problems observed in other programs, such as the Nota Fiscal Paulista program (Naritomi, 2019). The Receita Certa project showed a negative result in terms of number of documents issued per user, although it is probably the project with the greatest coverage.

3.4. Receita da Sorte, an instant lottery.

The new project Receita da Sorte distributes cash lottery prizes daily to citizens. In this project, the draw occurs instantly. There is no particular condition, except to request the insertion of the citizen's fiscal number in the fiscal invoice. The Receita da Sorte is a draw that takes place instantly, by reading the QR-Code of the Electronic Consumer Invoice (NFC-e) containing the consumer's CPF. The usage of the smartphone's camera to read the QR code has recently become optional because, as soon as the electronic note is issued, it is already available in the application and only requires a click to verify if you have been drawn or not.

The App even sends a notification that the note is available but requires alerts to be enabled on the smartphone. This recent innovation in the App is in line with the trend that invoices are no longer printed, reducing paper issuance. It has already become a common practice for commercial establishments to ask consumers if they want the printed note. The tax documents are available on the App to check whether you have won or not while the extraction cycle is valid, which is normally one day. The first prize of the Receita da Sorte took place in December 2019. Participation takes place through the Nota Fiscal Gaúcha Program app, and after issuing the note, click on the Receita da Sorte icon.

The initiative started with 30 prizes per day and from 2024 it reached 2,600 prizes per day. Prizes of BRL 50.00 and BRL 500.00 are normally used. The only tax document that participates in the Receita da Sorte is the Electronic Consumer Invoice (NFC-e), notes with QR-Code. The invoice must have been issued with the same identification as the person logged into the application, and the NFC-e must be read within the draw's validity period. Prize redemption can be requested in the app itself.

Receita da Sorte is an instantaneous lottery modality integrated into the Nota Fiscal Gaúcha program. Unlike the traditional monthly lottery, which provides delayed draws and rewards, Receita da Sorte informs participants in real time whether they have won a prize. This structure transforms each transaction into an immediate probabilistic reward event, increasing the frequency of interaction and reinforcing repeated participation through continuous exposure to uncertain outcomes.

Empirical evidence indicates that Receita da Sorte generated substantially stronger behavioural effects than the traditional monthly lottery. While the monthly lottery increased invoice issuance by 1.33 documents per period (approximately 30%), Receita da Sorte increased issuance by 4.35 documents (approximately 99%), representing an effect approximately three times greater. Similarly, the monthly lottery increased invoice value by BRL 36.62 (11%), whereas Receita da Sorte increased it by BRL 97.56 (28%).

The subgroups analysis shows stronger effect in Upper subgroup, an impact of 144% in number of documents, much higher than the 99% of the group analysis of Receita da Sorte. The Upper subgroup in the starting point shows 6.34 documents issued and, at final period, 14.82 documents, whereas the control group shows for the same points 3.28 and 4.41 (Tonetto et al., 2025). These behavioural patterns suggest dynamics consistent with gambling addiction mechanisms. This can be attributed to the overall experience involved, particularly the use of a smartphone, the expectation of an instant prize, and the ability to verify the outcome within

seconds, almost in real time. This immediate resolution of uncertainty, combined with repeated exposure and probabilistic rewards, activates cognitive and physiological responses associated with anticipation and reward processing, reinforcing continued participation. At the municipal level analysis, the effects are modest, with a small increase in the number of documents in the community, indicating a limited but statistically robust herd effect.

3. Research Methodology

This study relies on administrative records covering the full population of interest over the entire observation period. The dataset represents the complete universe of eligible observations within the institutional scope of the program, rather than a statistical sample. Since the policy was unique to Rio Grande do Sul and no comparable units with identical structural and operational characteristics exist, a cross-sectional or panel framework is not feasible. Consequently, the empirical variation exploited in this study is temporal, and the identification strategy relies on time series analysis, which is appropriate for evaluating policy effects in settings where the intervention affects a single institutional environment over time.

Statistical tests provide valuable information in economic analysis, but in many periods of economic life, they are not necessary to distinguish between different realities. In some cases, conventional tests do not detect a series of changes in the parameters of econometric models, while some changes are obvious and easy to identify (Hendry, 2000). To achieve the objectives in this study, we applied an analysis of structural breaks in the number of subscribers in NFG program, from November 2012 to May 2023, 127 observations that represent more than 10 years of the program.

The use of structural break (SB) analysis allows the identification of significant changes at specific moments when there is a change in the relationship between variables, and contributes to a better specification of models, eliminating biases in the estimated parameters that may occur if breaks are ignored. In terms of hypothesis validation, SB analysis identifies statistically significant changes in a time series and allows researchers to assess whether these changes are temporally associated with exogenous events such as public policies, economic crises, or climate shocks.

In this specific case, the identification of SB enables the verification of whether there has been a shift in addition of subscribers. Consequently, it becomes possible to determine whether these breaks are associated with the new projects. In the test carried out in this study, Y represented the accumulated number of subscriptions, while the explanatory variable was the time trend. Several tests can detect structural breaks, including the Chow, CUSUM, and QLR tests. In this study, these tests were used alongside Bai & Perron's (1998) method of identifying multiple breaks.

The data were obtained from the RS Revenue Agency; however, we did not have access to information regarding the gender or income bracket of new NFG subscribers. If such details were available, they would enable more in-depth analyses.

In general, there is a large economic and statistical literature emphasizing a single structural break or change. The development of a method to detect multiple structural changes at unknown dates using a linear regression model estimated by least squares represented a step forward. The main advantages of this method are related to detecting multiple structural changes, estimating their break dates and determining number of breaks (Bai & Perron, 1998). The application of tests for parameter instability and structural change with an unknown change point is appropriate in many cases. In some instances, the change point may be known

from a hypothesis being tested and in others it may be completely unknown. The change may also be in a restricted interval (Donald, 1993). Forecasting analyses often consist of a constant and time-invariant data generation process, which may imply the exclusion of structural changes in the economy. This may result in inaccurate forecasts, as it neglects significant aspects of the real world (Clements & Hendry, 1996).

Many articles use structural break analysis to assess public policies and finances. For example, a study on the sustainability of the fiscal policy of the state of Rio Grande do Sul, involving the primary balance and public debt, used the SB presence test (Oliveira & Pias, 2021). In an analysis of the evolution of the Brazilian public debt, the method of identifying multiple structural breaks was used, especially the Chow test.

If there is prior information exogenous to the data suggesting a potential failure on a certain date due to an institutional change, this information can and should be used without restriction. When the information is truly exogenous, it will not distort the dimensional properties and is likely to produce a test with substantial power. However, the data may indicate a slightly different date. This discrepancy may occur because major adjustments or changes in behaviour often do not align precisely with the institutional change date. The dates used to check for structural breaks are those correlated with the four tax compliance projects (Lopes, 2021). Our study employs structural break analysis to evaluate the potential impacts of tax compliance projects over time, a relatively uncommon approach in tax compliance research. Additionally, this study, incorporates exogenous information that suggests probable break dates, corresponding to the initiation of the projects.

The SB analysis identified three significant breaks. The possible explanations for the breaks identified by the QLR, Cusum-sq and Bai & Perron's method are in Table 2. The first SB was identified near the period in which the amount allocated to NFG prizes experienced an abrupt reduction. The second SB occurred shortly after the launch of the Menor Preço Brazil and Receita da Sorte projects. The final SB was detected by two methods, Bai & Perron, and QLR, in Sep/Oct 2021, close to the implementation period of the Devolve-ICMS and Receita Certa projects.

The first structural break, identified in November 2014, coincided with a period of severe fiscal deterioration in Rio Grande do Sul. Following the transition to a new state administration in early 2015, fiscal constraints intensified and the resources allocated to NFG prizes were substantially reduced. Although the structural break cannot be interpreted as a purely causal effect of the reduction in prizes, the timing suggests that the fiscal adjustment period and the associated reduction in program incentives were closely related to the observed change in subscriber dynamics.

Table 2: Dates of Breaks Detected

Break/Method	Data	Justification
Bai & Perron 1st break	2014/11	Abrupt drop in the value of premiums
Cusum-SQ	2020/04	Launch of Menor Preço Brazil and the Receita da Sorte
QLR	2021/09	Launch of the project Devolve-ICMS and Receita Certa
Bai & Perron 2nd break	2021/10	Launch of the project Devolve-ICMS and Receita Certa

Source: Compiled by the authors.

Although the estimated break dates do not necessarily coincide exactly with the official launch dates of the projects, this pattern is expected in policy evaluations. Behavioural responses may occur with anticipation, implementation delays, dissemination effects, or gradual adoption by citizens. Therefore, the structural breaks should be interpreted as statistically significant changes occurring within the broader implementation period of each policy intervention rather than as exact reflections of the official launch date. The SB analysis of NFG`s subscribers utilized Bai & Perron's method, which was further complemented by the Cusum, Cusum-SQ, and QLR tests. In summary, multiple breaks were initially estimated and subsequently a time-series regression analysis was performed to verify the influence on new subscribers of the NFG program. The first model included dummy variables representing the structural breaks found. This approach was used to explore possible associations between the break dates and changes in the number of subscribers. The following models were estimated:

$$lnew_subs = \alpha + \beta 1\ lprize_up + \beta 2\ IPCA_Index + \beta 3\ Com_var + \beta 4\ D1_RS_MP + \beta 5\ D2_DE_RC + \beta 6\ D3_Value + \varepsilon, \quad (1)$$

$$lnew_subs = \alpha + \beta 1\ lprize_up + \beta 2\ IPCA_Index + \beta 3\ Com_var + \varepsilon, \quad (2)$$

where: α and β are the estimated parameters and ε is the residual of the models, and the other variables are defined in Table 3.

The number of observations were 127 at beginning, and after cleaning missing data we had 113 observations.

Table 3: Variables and Descriptive Statistics

Acronyms	Description	Min	Mean	Max	Source
Time	Months	Mar 2013	Mar 2018	Apr 2023	Sefaz/RS
New_subs	Number of new subscribers to the NFG program	5,635	24,654	125,547	Sefaz/RS
Total_subs	Total subscribers to the NFG program	127,538	1,593,938	3,051,469	Sefaz/RS
lnew_subs	Logarithm of the number of new subscribers to the NFG program	8.64	9.74	11.74	Sefaz/RS
lprize_up	Logarithm of the total monthly amount distributed	11.19	13.94	18.65	Sefaz/RS
IPCA_Index	Inflation Index of Brazil - IPCA	3,672	5,015	6,650	IBGE
Com_var	Retail trade volume variation index in RS	72.92	90.77	123.52	IBGE
D1_RS_MP	Dummy from SB. The period of Menor Preço Brazil and Receita da Sorte projects	0	0.354	1	Cusum-SQ
D2_DE_RC	Dummy from SB. The period of the Devolve-ICMS and Receita Certa projects	0	0.1504	1	Bay and Perron; QLR
D3_Value	Dummy from SB. Drastic reduction in the value of the program from Feb 2015 to Oct 2016	0	0.1681	1	Bay and Perron

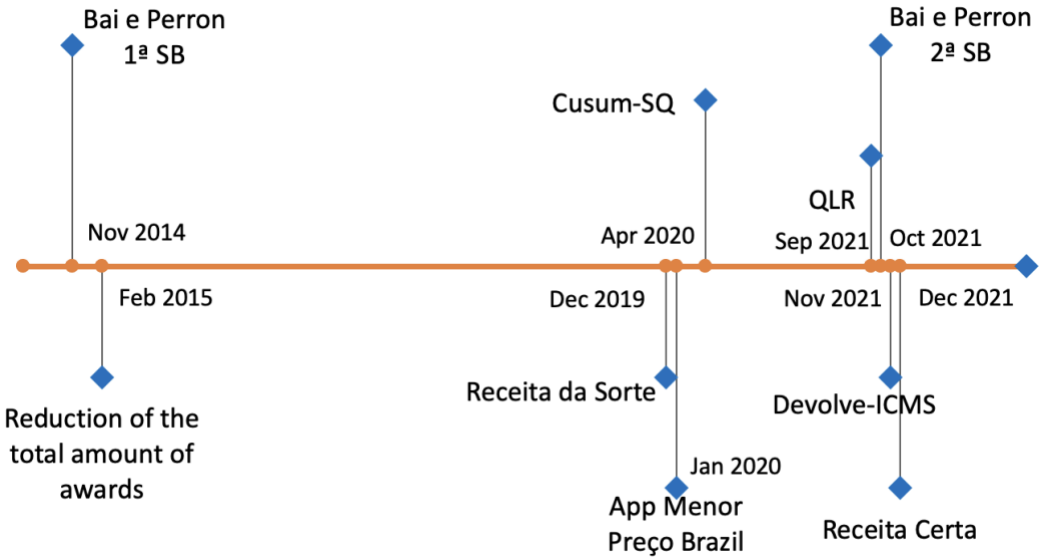
Source: Revenue Agency of RS (SEFAZ/RS). Instituto Brasileiro de Geografia e Estatística (IBGE). Prepared by the authors.

5. Results and Discussion

The time series analysis of NFG`s subscribers numbers utilized Bai & Perron's method, which was further complemented by the Cusum, Cusum-SQ, and QLR tests. These methods were validated using the Chow test. However, the Cusum test did not provide reliable information. Exogenous events that suggest a structural break are include in the figure 5, such the moment was a great reduction in the monthly prizes. In the second semester of 2014 the average of the monthly rewards distributed were BRL 900,000 (around USD 180,000), falling to BRL 292,000 (USD 58,400) in the first semester of 2015. This is 67% lower.

Figure 5 shows all the structural breaks founded using statistical tests and exogenous event dates. Bai & Perron's method identified two structural break dates: Nov 2014 and Oct 2021. The Cusum-sq test pointed a break in Apr 2020. The QLR test identified a break in Sep 2021. The QLR is an endogenous method.

Figure 5: Policy Interventions and Structural Breaks in Subscriber Engagement



Note: Dates below the timeline indicate policy or administrative changes, while dates above indicate econometric structural breaks (Bai–Perron, CUSUM-SQ, and QLR). Breaks represent significant changes in subscriber growth.

Source: Compiled by the authors.

The results suggest that the projects were effective in increasing enrolment in the NFG program. The number of registered participants has already surpassed 3.5 million citizens, representing over 30% of the state's total population of 10.8 million. When accounting for previous estimates that the adult population constitutes 75% of the total, the participation rate rises to nearly 40%.

Table 4: Model Results Estimated in Robust Form

Variables	Model 1	Model 2
(Intercept)	11.372 ***	4.335 ***
	(0.974)	(0.462)
lprize_up	0.066	0.299 ***
	(0.052)	(0.045)
IPCA_Index	-0.001 ***	0.000
	(0.000)	(0.000)

Variables	Model 1	Model 2
Com_var	0.013 ***	0.020 **
	(0.003)	(0.006)
D1_RS_MP	0.284*	
	(0.135)	
D2_DE_RC	2.009 ***	
	(0.277)	
D3_Value	-0.532 ***	
	(0.101)	
N	113	113
R^2	0.72	0.401
logLik	-61.314	-104.369
AIC	138.628	218.738

Source: Compiled by the authors. Note: *** p < 0.001; ** p < 0.01; * p < 0.05.

Model 1, which incorporates the structural break dummies, is superior in terms of explanatory power and overall fit. It accounts for 72% of the variance, compared to only 40.1% for Model 2, and also has a lower AIC and higher log-likelihood, affirming its greater suitability. The total monthly value allocated to prizes has the expected positive sign but is not significant. The only non-significant variable in Model 1 is lprize_up. The intercept indicates an expected mean value of 11.372 when all explanatory variables are set to zero. A one-unit increase in the monthly inflation index corresponds to an approximately 0.1% reduction in the number of new subscribers. Although this effect is small, it is statistically significant. Conversely, a one-unit increase in the monthly variation index of RS commerce is associated with a significant 1.3% increase in new subscribers, indicating a correlation with overall economic performance

All dummies are significant, with Receita da Sorte and Menor Preço Brazil showing the lowest significance at 0.05 level, while the remaining dummies exhibit significance at 0.001 level. The first dummy (Menor Preço Brazil and Receita da Sorte) is associated with 32.8% increase in new subscribers ($e^{0.284}-1$). Both projects rely heavily on smartphone app technology, which may limit their effectiveness due to digital illiteracy.

The second dummy (Devolve-ICMS and Receita Certa) correlates with a substantial 635.4% increase in the number of new NFG participants ($e^{2.009}-1$). Both projects are broadly targeted. However, Devolve-ICMS is restricted to a group of 600,000 low-income individuals, who may have more limited access to information. In contrast, Receita Certa aims to reach the entire taxpayer population. Both projects are based on a cashback mechanism, which may suggest that perceptions of fairness play a stronger role in shaping individuals' motivation. These results should be interpreted as associations between the implementation period of the projects and subscriber growth, rather than definitive causal effects

Dummy 3, which represents a period marked by a sharp reduction in prize distribution due to the fiscal crisis in RS, is associated with a 41.3% decline in new registrations. The results raise an important policy question. During periods of fiscal stress, governments often reduce expenditures associated with tax compliance programs. However, because such programs are designed to increase citizen engagement and encourage tax compliance, reductions in incentives may generate unintended consequences, potentially weakening the

very mechanisms that contribute to revenue collection. This finding suggests that policy discontinuity may substantially reduce citizen engagement, highlighting the importance of stable institutional frameworks for sustaining tax compliance programs during periods of fiscal adjustment.

Both the Receita da Sorte and Menor Preço projects, along Devolve-ICMS and Receita da Sorte, exhibit significant positive structural impacts. To sustain and grow membership in the NFG program, boosting the four projects and maintaining attractive prizes levels is a promising strategy to boost the four projects, as well as. However, challenges remain. The Devolve-ICMS project has successfully implemented the variable portion of the tax refund but is inherently limited by the low income of eligible participants. The Receita Certa project requires redesign, as it initially attracted many citizens to the NFG program but has demonstrated limited effectiveness in increasing the number of invoices requested (Tonetto et al., 2024a). Conversely, the Receita da Sorte project is clearly gaining momentum due to its technological approach and the preference for immediate rewards.

External factors, such as inflation, fiscal restrictions, and economic growth, as demonstrated in this research, have likely influenced both the program's outcomes and public participation in these initiatives. Consequently, while the structural breaks are consistent with the timing of major program interventions, other contemporaneous economic and institutional factors may also have contributed to the observed changes in subscriber behaviour.

Conclusion

The objective of this study is to contribute to the behavioural literature through a long-term time series analysis of citizen engagement in the Fiscal Education Program of Rio Grande do Sul, Brazil. The state has implemented four innovative tax compliance initiatives, although the program experienced periods of policy discontinuity, particularly in the magnitude of prizes allocated. The RS program represents a large-scale public policy combining tax education, monetary incentives, and transparency, using state-of-the-art digital tools and targeted behavioural interventions. We analysed taxpayer behaviour using a behavioural economics framework and applied time series regression models with structural break analysis to identify significant changes in new subscribers between November 2012 and May 2023, comprising 113 observations over more than ten years. The results indicate that these initiatives were effective because they incorporate behavioural mechanisms such as rewards, perceived fairness, social influence, and present bias, consistent with behavioural theory.

Structural break analysis identified three significant moments. The first was a reduction in prize values in November 2014, associated with a 41% decrease in new subscribers. The second corresponded to the launch of the Menor Preço Brasil app and Receita da Sorte, resulting in a 32% increase. The third, and most significant, occurred in late 2021 with the introduction of Devolve-ICMS and Receita Certa, generating a 635.4% increase in new subscribers. Inflation had a small negative effect.

The findings highlight the importance of policy continuity and demonstrate that perceived fairness, particularly when programs provide direct financial returns, plays a central role in sustaining taxpayer engagement. Reductions in prize value negatively affect participation, while instant or targeted rewards significantly increase engagement.

Beyond their behavioural effects, the digital tools analysed in this study also contribute to correcting market imperfections and reducing the tax gap. In particular, the Menor Preço Brasil application lowers consumers' search and transaction costs, reduces information

asymmetries between consumers and retailers, and improves market transparency by providing real-time price information based on electronic invoices. By allowing users to compare prices across establishments, evaluate distance, identify delivery options, and monitor recent price variations, the application helps consumers make more informed purchasing decisions and potentially reduce both monetary and transportation costs. At the same time, the app creates incentives for consumers to request invoices linked to their CPF, expanding the volume of documented transactions available to the tax authority. This mechanism aligns private benefits with public objectives, improving market transparency while strengthening tax compliance and reducing opportunities for underreporting, thereby contributing to a lower tax gap.

More broadly, the results suggest that digital government initiatives can play a dual role by simultaneously generating value for citizens and improving tax administration outcomes. When designed around tangible user benefits, such tools may help narrow the tax gap not only through traditional enforcement mechanisms, but also by fostering voluntary participation, transparency, and trust.

From a policy perspective, instant and visible rewards, improved communication, simplified redemption processes, and targeted incentives can significantly enhance engagement. Expanding redistributive projects such as Devolve-ICMS may also help reduce tax regressivity and strengthen voluntary compliance. Finally, integrating insights from behavioural sciences may further improve tax compliance policies.

Although this study focuses on a single Brazilian state, it covers a large population of over 10 million people and provides valuable insights. Future research should examine behavioural responses following Brazil's 2023 tax reform and further explore the interaction between tax administration, fairness perception, and taxpayer behaviour.

CRediT Authorship Contribution Statement

Jorge Luis Tonetto: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft. Josep Miquel Pique: Formal analysis, Writing – review & editing. Carina Rapetti: Formal analysis, Writing – review & editing. Adelar Fochezatto: Formal analysis, Writing – review & editing. All authors contributed to the interpretation of the results, critically reviewed and edited the manuscript, approved the final version for publication, and agreed to be accountable for all aspects of the work.

Funding Statement

This research received no external funding.

Conflict of Interest Statement

The author declares no conflicts of interest.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author, Jorge Luis Tonetto (jorgeluis.tonetto@salle.url.edu), for the purpose of reproducing the results reported in this article.

Ethical Approval Statement

This study is based exclusively on secondary administrative and aggregated data provided by the Revenue Agency of Rio Grande do Sul (SEFAZ/RS). The research does not involve human participants, human biological materials, animal subjects, surveys, interviews, or access to personally identifiable information. All data were analysed in anonymized and aggregated form for research purposes only.

Consequently, ethical approval from an Institutional Review Board (IRB) or Ethics Committee was not required under applicable research ethics guidelines. The study was conducted in accordance with the principles of research integrity, transparency, and responsible data use.

References

Alm, J. (2012). Measuring, explaining, and controlling tax evasion: Lessons from theory, experiments, and field studies. *International Tax and Public Finance, 19*(1), 54–77. https://doi.org/10.1007/S10797-011-9171-2

Alm, J. (2021). Tax evasion, technology, and inequality. *Economics of Governance,* 22, 321–343. https://doi.org/10.1007/s10101-021-00247-w

Alm, J., Burgstaller, L., Domi, A., März, A., & Kasper, M. (2023). Nudges, Boosts, and Sludge: Using New Behavioural Approaches to Improve Tax Compliance. *Economies*, *11*(9), 223. https://doi.org/10.3390/economies11090223

Ávila, F., & Bianchi, A. M. (2015). Guia de economia comportamental e experimental (1st Ed.). São Paulo: Editora EC. ISBN 978-85-5629-000-7. http://www.economiacomportamental.org/guia-economia-comportamental.pdf

Bachas, P., Flores, T., Lara Ibarra, G., Mantovani, A. A., Oliveira, E. S. de, Padilha, G., & Scot, T. (2025). VAT cashback programs in practice: The case of Devolve-ICMS in Rio Grande do Sul, Brazil (Prosperity Insight Series). World Bank Group. http://documents.worldbank.org/curated/en/099082825110521060

Bai, J., & Perron, P. (1998). Estimating and testing linear models with multiple structural changes. *Econometrica*, *66*(1), 47–78. https://doi.org/10.2307/2998540

Becker, S., Gandhi, W., Elfassy, N. M., & Schweinhardt, P. (2013). The role of dopamine in the perceptual modulation of nociceptive stimuli by monetary wins or losses. *European Journal of Neuroscience*, *38*(7), 3080–3088. https://doi.org/10.1111/ejn.12303

Bird, R. (2010). Smart tax administration. Economic Premise (No. 36). World Bank, Washington, DC. http://hdl.handle.net/10986/10152

Björklund Larsen, L. (2023). Game of tax: Rethinking the relationship between redistribution and reciprocity through a Georgian tax lottery. *Economic Anthropology, 10*(1), 100–111. https://doi.org/10.1002/sea2.12269

Bonner, S. E., & Sprinkle, G. B. (2002). The effects of monetary incentives on effort and task performance: Theories, evidence, and a framework for research. *Accounting, Organizations and Society, 27*(4–5), 303–345. https://doi.org/10.1016/S0361-3682(01)00052-6

Buehn, A., & Schneider, F. (2016). Size and development of tax evasion in 38 OECD countries: What do we (not) know? *Journal of Economic and Political Economy*, *3*(1), 1–11. Retrieved from https://journals.econsciences.com/index.php/JEPE/article/view/634

Carpenter, J. P., Garcia, J. R., & Lum, J. K. (2011). Dopamine receptor genes predict risk preferences, time preferences, and related economic choices. *Journal of Risk and Uncertainty*, *42*(3), 233–261. https://doi.org/10.1007/s11166-011-9115-3

Carvalho, H. C., Afonso, A, & Mazzon, J. A. (2023). Tax compliance in the wild: Critical review of nudging and proposition of an integrative framework. *BAR-Brazilian Administration Review*, *20*(1), e220040. https://doi.org/10.1590/1807-7692bar2023220040

Cebula, R. J., & Feige, E. L. (2012). America's unreported economy: Measuring the size, growth, and determinants of income tax evasion in the US Crime, *Law and Social Change*, *57*(3), 265–285. https://doi.org/10.1007/s10611-011-9346-x

Clements, M. P., & Hendry, D. F. (1996). Intercept corrections and structural change. *Journal of Applied Econometrics*, *11*(5), 475–494. https://doi.org/10.1002/(SICI)1099-1255(199609)11:5<475::AID-JAE409>3.0.CO;2-9

Costa, A. C. A. D. R., Krieger, M. G. M., & Fontoura, Y. (2022). Fiscal compliance and behavioural economics: an analysis of the influence of the decision context. *Brazilian Journal of Political Economy, 42*(1), 1062–1079. https://doi.org/10.1590/0101-31572022-3343

Deci, E. L., & Ryan, R. M. (Eds.) (1985). *Intrinsic Motivation and Self-Determination in Human Behaviour.* Series Title Perspectives in Social Psychology. Springer New York, NY. https://doi.org/10.1007/978-1-4899-2271-7

DellaVigna, S. (2009). Psychology and economics: Evidence from the field. *Journal of Economic Literature*, *47*(2), 315–372. https://www.jstor.org/stable/27739926

Fabbri, M. (2015). Shaping tax norms through lotteries. *International Review of Law and Economics*, *44*, 8–15. https://doi.org/10.1016/j.irle.2015.07.002

Fabbri, M., & Hemels, S. (2013). "Do you want a receipt?" Combating VAT and sales tax evasion with lottery tickets: Involving customers. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2232249

Feld, L. P., & Frey, B. S. (2006). Tax compliance as the result of a psychological tax contract: The role of incentives and responsive regulation. CREMA Working Paper, No. 2006-10. https://hdl.handle.net/10419/214356

Fehr, G., Kamm, A., & Jäger, M. (2015). The behavioural change matrix - A tool for evidence-based policy making. In A. Samson (Editor), *The Behavioural Economics Guide* 2015. http://www.behavioraleconomics.com

Gamannossi degl'Innocenti, D., & Rablen, M. D. (2020). Tax evasion on a social network. *Journal of Economic Behaviour and Organization*, *169*, 79–91. https://doi.org/10.1016/J.JEBO.2019.11.001

Gautam, V. (2012). An empirical study on financial products offered by Indian retail banks to assess the relationship between sale promotions, time to reward receipt, and customer preference. *Journal of Relationship Marketing, 11*(4), 233–247. https://doi.org/10.1080/15332667.2012.730969

Gertler, P. J., Martinez, S., Premand, P., Rawlings, L. B., & Vermeersch, C. M. J. (2018). Avaliação de impacto na prática. Washington, DC: Banco Mundial. https://openknowledge.worldbank.org/server/api/core/bitstreams/4d0504c2-bedf-5218-939b-cc17b3c238f3/content

Hahn, A., Reed, M. B., Pichler, V., Michenthaler, P., Rischka, L., Godbersen, G. M., Wadsak, W., Hacker, M., & Lanzenberger, R. (2021). Functional dynamics of dopamine synthesis during monetary reward and punishment processing. *Journal of Cerebral Blood Flow & Metabolism, 41*(11), 2973–2985. https://doi.org/10.1177/0271678X211019827

Hendry, D. F. (2000). On detectable and non-detectable structural change. *Structural Change and Economic Dynamics*, *11*(1), 45–65. https://doi.org/10.1016/S0954-349X(00)00020-5

Kachelmeier, S. J., & Shehata, M. (1992). Examining risk preferences under high monetary incentives: Experimental evidence from the People's Republic of China. *The American Economic Review*, *82*(5), 1120–1141. http://www.jstor.org/stable/2117470

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, *47*(2), 263–291. https://doi.org/10.2307/1914185

Kandel, E. R., Schwartz, J. H., Jessell, T. M., Siegelbaum, S., Hudspeth, A. J., & Mack, S. (Eds.). (2000). Principles of neural science. New York: McGraw-Hill.

Keh, H., & Lee, Y. (2006). Do reward programs build loyalty for services? The moderating effect of satisfaction on type and timing of rewards. *Journal of Retailing*, *82*(2), 127–136. https://doi.org/10.1016/j.jretai.2006.02.004

Lopes, A. S. (2021). Uma introdução à análise de estabilidade dos coeficientes. Lisboa: ISEG/ULISBOA. http://hdl.handle.net/10400.5/17668

Mazzucato, M. (2021). Mission Economy. A moonshot guide to changing economy. https://marianamazzucato.com/books/mission-economy/

McClure, S. M., Laibson, D. I., Loewenstein, G., & Cohen, J. D. (2004). Separate neural systems value immediate and delayed monetary rewards. *Science*, *306*(5695), 503–507. https://doi.org/10.1126/science.1100907

Nicolaides, P. (2024). Characteristics and responses of winners in the Greek tax lottery. *International Tax and Public Finance*, 1–46. https://doi.org/10.1007/s10797-024-09872-7

Oliveira, C. A., & Pias, D. (2021). The Sustainability of Fiscal Policy in the Presence of Structural Breaks: An Evidence from Rio Grande Do Sul (A sustentabilidade da política fiscal na presença de quebras estruturais: Uma evidência para o Rio Grande do Sul). *Planejamento e Políticas Públicas*, 54. https://doi.org/10.38116/ppp54art05

Paleka, H., & Vitezić, V. (2023). Tax Compliance Challenge through Taxpayers' Typology. *Economies*, *11*(9), 219. https://doi.org/10.3390/economies11090219

Purves, D., Augustine, G. J., Fitzpatrick, D., Hall, W. C., LaMantia, A., Mooney, R., & White, L. E. (2018) Neuroscience. 6th Edition, Sinauer Associates, New York. ISBN-13: 978-1605353807

Samson, A. (2014). The Behavioural Economics Guide. Available in: https://www.behavioraleconomics.com/be-guide/the-behavioral-economics-guide-2014/

Sanfey, A. G., Rilling, J. K., Aronson, J. A., Nystrom, L. E., & Cohen, J. D. (2003). The neural basis of economic decision-making in the Ultimatum Game. *Science*, *300*(5626), 1755–1758. https://doi.org/10.1126/science.1082976

Saptono, P. B., Mahmud, G., Salleh, F., Pratiwi, I., Purwanto, D., & Khozen, I. (2024). Tax Complexity and Firm Tax Evasion: A Cross-Country Investigation. *Economies*, *12*(5), 97. https://doi.org/10.3390/economies12050097

Shampanier, K., Mazar, N., & Ariely, D. (2007). Zero as a special price: The true value of free products. *Marketing Science*, *26*(6), 742–757. https://doi.org/10.1287/mksc.1060.0254

Slemrod, J. (2007). Cheating ourselves: The economics of tax evasion. *Journal of Economic Perspectives*, *21*(1), 25–48. https://doi.org/10.1257/jep.21.1.25

Slemrod, J. (2024). What taxpayers, governments and tax economists do – and what they should do. *Fiscal Studies*, *45*(1), 7–19. https://doi.org/10.1111/1475-5890.12324

Souza, T. S. C. de, & Souza, P. A. C. de. (2018). Desenvolvendo projetos para disseminação da cidadania fiscal. In: Educação fiscal e cidadania. Porto Alegre: Editora da UFRGS/CEGOV.

Sunstein, C., & Thaler, R. H. (2019). Nudge: Como tomar melhores decisões sobre saúde, dinheiro e felicidade. Rio de Janeiro: Objetiva. ISBN–13: 978-8547000806. https://www.amazon.com.br/Nudge-melhores-decis%C3%B5es-dinheiro-felicidade/dp/8547000801

Tonetto, J. L. (2026). *The digital government: Innovation and data-driven tax compliance*. Simplíssimo Livros. https://doi.org/10.71019/855716

Tonetto, J. L., Fochezatto, A., & da Silva, G. P. (2023a). Refund of consumption tax to low-income people: Impact assessment using difference-in-differences. *Economies*, *11*(6), 153. https://doi.org/10.3390/economies11060153

Tonetto, J. L., Fochezatto, A., & Pique, J. M. (2023b). The impact of the COVID-19 pandemic on the use of the Menor Preço Brasil application. *Administrative Sciences*, *13*(11), 229. https://doi.org/10.3390/admsci13110229

Tonetto, J. L., Fochezatto, A., & Pique, J. M. (2024a). Monetary incentives to improve tax compliance: A Brazilian case study. *Development Policy Review*, e12770. https://doi.org/10.1111/dpr.12770

Tonetto, J. L., Pique, J. M., Fochezatto, A., & Rapetti, C. (2024b). Tax evasion and company survival: A Brazilian case study. *Economies*, *12*(11), 286. https://doi.org/10.3390/economies12110286

Tonetto, J. L., Fochezatto, A., Pique, J. M., & Rapetti, C. (2025). Instant lottery innovation, tax compliance and herd effects, an impact assessment in Brazil. *Annals of Public and Cooperative Economics*, *96*, 609–633. https://doi.org/10.1111/apce.70003

Torgler, B. (2003). Tax Morale, Rule-Governed Behaviour and Trust. *Constitutional Political Economy 14*, 119–140. https://doi.org/10.1023/A:1023643622283

Torgler, B. (2004). Tax morale, trust and corruption: Empirical evidence from transition countries. CREMA Working Paper, No. 2004-05. Center for Research in Economics, Management and the Arts (CREMA), Basel. https://hdl.handle.net/10419/214291

Wenzel, M. (2005). Misperceptions of social norms about tax compliance: From theory to intervention. *Journal of Economic Psychology*, *26*(6), 862–883. https://doi.org/10.1016/j.joep.2005.02.002

World Bank. (2025). Behavioural insights for tax compliance: A whole-house approach to improving taxpayer and tax official beliefs, attitudes, and behaviours (Policy Note). The World Bank. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099801507312541118

Zald, D. H., Boileau, I., El-Dearedy, W., Gunn, R., McGlone, F., Dichter, G. S., & Dagher, A. (2004). Dopamine transmission in the human striatum during monetary reward tasks. *The Journal of Neuroscience*, *24*(17), 4105–4112. https://doi.org/10.1523/JNEUROSCI.4643-03.2004

How to cite this article:

Tonetto, J. L., Pique, J. M., Fochezatto, A., Rapetti, C. (2026). Fiscal Incentive Design and Digital Governance: A Time-Series Analysis of Tax Compliance in Southern Brazil. *Applied Journal of Economics, Law and Governance*, Volume II, Issue 1(3), 157-180. https://doi.org/10.57017/ajelg.v2.i1(3).09

Article's history:

Received 21st of April, 2026; Revised 31st of May, 2026;
Accepted for publication 9th of June, 2026; Available online: 15th of June, 2026;
Published as research article in Volume II, Issue 1(3), 2026.

© The Author(s) 2026. Published by RITHA Publishing. This article is distributed under the terms of the license CC-BY 4.0., which permits any further distribution in any medium, provided the original work is properly cited maintaining attribution to the author(s) and the title of the work, journal citation and URL DOI.