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JORGE LUÍS TONETTO

INNOVATION IN PUBLIC POLICY:
EVALUATING THE CASE STUDIES FROM *RIO GRANDE DO SUL*

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do Rio Grande do Sul

JORGE LUÍS TONETTO

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Tese de doutorado apresentada como requisito parcial para obtenção do grau de Doutor em Economia do Desenvolvimento, pelo Programa de Pós-Graduação em Economia do Desenvolvimento da Escola de Negócios da Pontifícia Universidade Católica do Rio Grande do Sul.

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Orientador: Prof. Dr. Adelar Fochezatto

Coorientador: Prof. Dr. Josep Miquel Piqué Huerta

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JORGE LUIS TONETTO

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Data: 13/05/2024 20:56:57-0300
Verifique em <https://validar.it.gov.br>

Prof. Dr. Adelar Fochezatto


Orientador e Presidente da sessão

JOSEP MIQUEL PIQUE HUERTA - DNI 52173720Z
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Prof. Dr. Josep Miquel Piqué Huerta
coorientador

Documento assinado digitalmente
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Prof. Dr. Adalmir Marquetti

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*To my parents Alfredo and Irma
(in memorian), my family and friends.*

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ABSTRACT

This thesis comprises three essays that relate to tax innovations that occurred in Rio Grande do Sul State from 2019 to 2022. The State's main revenue is an indirect tax on consumption, which has the characteristics of regressivity and fiscal anesthesia. The innovations presented and evaluated in this thesis comprise solutions for these issues. Thus, in the first essay we present a study that aims to verify the impact of the COVID-19 pandemic on the use of the *Menor Preço Brasil* app service. To this end, it investigates both the correlation between confirmed cases of COVID-19 in Brazil and the changes in the application's functionalities with the variation in citizens' queries to the application. For this purpose, the method of identifying multiple structural breaks and regression models are employed. The results indicate that a 1% increase in COVID-19 cases led to a 0.2% increase in queries. The results confirm also that user behavior related to application was influenced by the change in the app's feature and by inflation rates. In the second essay, we study the program (the Devolve-ICMS Program) that refunds consumption tax to low-income citizens (cashback). This study aims to evaluate the impacts of this Program using a differences-in-differences model and having, as response variables, the monthly sum of electronic invoices issued to the Program's beneficiaries, as well as their value. The results show that the Program is effective, as it has reduced tax pressure on poor people and increased both the number of invoices issued and their value. Finally, the last essay is about the use of monetary incentives through Receita Certa project. Targeted at the commerce sector, this initiative offers cashback rewards, refunding a portion of the consumption tax to citizens. This study evaluates the impacts of *Receita Certa* using a difference-in-differences model. The response variables are the monthly number and value of electronic invoices issued to beneficiaries. Refunds are contingent on certain conditions, such as revenue exceeding inflation. The results show that the *Receita Certa* is ineffective, as it decreased the number of tax documents issued and it is not significant about variable value of the documents. Additionally, the initiative's cost was high, highlighting the need for reevaluation and refinement. States that have a large tax gap need to improve their control systems. Initiatives such as those presented in this thesis seek to engage taxpayers in combating evasion, some more successfully than others. The objective of these studies was to contribute to better public policies in tax administration.

Keywords: Tax Evasion; Innovation; Digital Government; Behavioral Economics; Difference-in-differences panel.

RESUMO

Esta tese é composta por três ensaios que tratam das inovações tributárias ocorridas no Rio Grande do Sul no período de 2019 a 2022. A principal receita do Estado é um imposto indireto sobre o consumo, que possui características de regressividade e anestesia fiscal. As inovações apresentadas e avaliadas nesta tese compreendem soluções para estas questões. Assim, no primeiro ensaio apresentamos um estudo que tem como objetivo verificar o impacto da pandemia de COVID-19 na utilização do serviço do aplicativo Menor Preço Brasil. Para tanto, investiga tanto a correlação entre os casos confirmados de COVID-19 no Brasil quanto as alterações nas funcionalidades do aplicativo com a variação nas consultas dos cidadãos ao aplicativo. São empregados o método de identificação de múltiplas quebras estruturais e modelos de regressão. Os resultados indicam que um aumento de 1% nos casos de COVID-19 levou a um aumento de 0,2% nas consultas. Os resultados confirmam também que o comportamento do usuário em relação ao aplicativo foi influenciado pela mudança nas funcionalidades do aplicativo e pelas taxas de inflação. No segundo ensaio, estudamos o Programa Devolve-ICMS que restitui imposto sobre consumo a cidadãos de baixa renda. Este estudo visa avaliar os impactos deste programa utilizando um modelo de diferenças em diferenças e tendo como variáveis de resposta o somatório mensal das faturas eletrônicas emitidas aos beneficiários do programa, bem como o seu valor. Os resultados mostram que o programa é eficaz, pois reduziu a pressão fiscal sobre as pessoas mais pobres e aumentou tanto o número de faturas emitidas como o seu valor. Por fim, o último ensaio trata da utilização de incentivos monetários através do projeto Receita Certa. Direcionada ao setor do comércio, esta iniciativa oferece como recompensa a devolução de uma parte do imposto sobre o consumo aos cidadãos. Este estudo avalia os impactos do Receita Certa utilizando um modelo de diferença em diferenças. As variáveis de resposta são o número e o valor mensal das faturas eletrônicas emitidas aos beneficiários. Para haver reembolso é necessário que a arrecadação do setor do comércio exceda a inflação. Os resultados mostram que a Receita Certa é ineficaz, pois diminuiu o número de documentos fiscais emitidos e não é significativo quanto a variável valor dos documentos. Além disso, o custo da iniciativa foi elevado, evidenciando a necessidade de reavaliação do projeto. Os Estados que registam um grande déficit fiscal necessitam melhorar os seus sistemas de controle. Iniciativas como as apresentadas nesta tese procuram envolver os contribuintes no combate à evasão, algumas com mais sucesso do que outras. O objetivo desses estudos foi contribuir para melhores políticas públicas na administração tributária.

Palavras-chave: Evasão Fiscal. Inovação. Governo Digital. Economia Comportamental. Painel de diferenças em diferenças.

RESUMEN

Esta tesis está compuesta por tres ensayos que abordan las innovaciones tributarias ocurridas en Rio Grande do Sul en el período de 2019 a 2022. El principal ingreso del Estado es un impuesto indirecto al consumo, que tiene características de regresividad y anestesia fiscal. Las innovaciones presentadas y evaluadas en esta tesis comprenden soluciones a estos problemas. Así, en el primer ensayo presentamos un estudio que tiene como objetivo verificar el impacto de la pandemia COVID-19 en el uso del servicio de la aplicación Menor Preço Brasil. Para ello, investiga tanto la correlación entre los casos confirmados de COVID-19 en Brasil como los cambios en las funcionalidades de la aplicación con la variación de las consultas de los ciudadanos a la aplicación. Se utiliza el método de análisis de rupturas estructurales y modelos de regresión. Los resultados indican que un aumento del 1% en los casos de COVID-19 llevó a un aumento del 0,2% en las consultas. Los resultados también confirman que el comportamiento del usuario en relación con la aplicación se vio influenciado por cambios en las funcionalidades de la aplicación y las tasas de inflación. En el segundo ensayo, estudiamos el programa Devolve-ICMS que reembolsa el impuesto al consumo a ciudadanos de bajos ingresos. Este estudio tiene como objetivo evaluar los impactos de este programa utilizando un modelo de diferencias en diferencias y teniendo como variables de respuesta el monto mensual de las facturas electrónicas emitidas a los beneficiarios del programa, así como su valor. Los resultados muestran que el programa es efectivo, ya que redujo la presión fiscal sobre las personas más pobres y aumentó tanto el número de facturas emitidas como su valor. Finalmente, el último ensayo aborda el uso de incentivos monetarios a través del proyecto Receita Certa. Dirigida al sector del comercio, esta iniciativa ofrece como recompensa la devolución de parte del impuesto a los ciudadanos. Este estudio evalúa los impactos utilizando un modelo de diferencias en diferencias. Las variables de respuesta son el número y valor mensual de facturas electrónicas emitidas a los beneficiarios. Para que se produzca el reembolso, los ingresos del sector comercial deben superar la inflación. Los resultados muestran que el proyecto es ineficaz, ya que reduce el número de documentos tributarios emitidos y no es significativa la variable valor de los documentos. Además, el costo de la iniciativa es alto, lo que resalta la necesidad de reevaluar el proyecto. Los estados que registran un gran déficit fiscal necesitan mejorar sus sistemas de control. Iniciativas como las presentadas en esta tesis buscan involucrar a los contribuyentes en el combate a la evasión, algunas con más éxito que otras. El objetivo de estos estudios fue contribuir a mejores políticas públicas en la administración tributaria.

Palabras clave: Evasión Fiscal. Innovación. Gobierno Digital. Conducta económica. Panel de diferencias en diferencias.

RESUM

Aquesta tesi està formada per tres assaigs que tracten les innovacions fiscals que es van produir a *Rio Grande do Sul* en el període 2019-2022. El principal ingrés de l'Estat és un impost indirecte sobre el consum, que té característiques de regressivitat i anestèsia fiscal. Les innovacions presentades i avaluades en aquesta tesi comprenen solucions a aquests problemes. Així, en el primer assaig presentem un estudi que pretén comprovar l'impacte de la pandèmia COVID-19 en l'ús del servei d'aplicacions *Menor Preço Brasil*. Amb aquesta finalitat, investiga tant la correlació entre els casos confirmats de COVID-19 al *Brasil* com els canvis en les funcionalitats de l'aplicació amb la variació de les consultes dels ciutadans a l'aplicació. S'utilitza el mètode d'identificació de múltiples trencaments estructurals i models de regressió. Els resultats indiquen que un augment de l'1% dels casos de COVID-19 va provocar un augment del 0,2% de les consultes. Els resultats també confirmen que el comportament dels usuaris en relació amb l'aplicació es va veure influenciat pels canvis en les funcionalitats de l'aplicació i les taxes d'inflació. En el segon assaig, vam estudiar el Programa *Devolve-ICMS* que reemborsa l'impost sobre el consum als ciutadans de baixos ingressos. Aquest estudi pretén avaluar els impactes d'aquest programa mitjançant un model de diferència en diferències i tenint com a variables de resposta la suma mensual de les factures electròniques emeses als beneficiaris del programa, així com el seu valor. Els resultats mostren que el programa és efectiu, ja que va reduir la pressió fiscal sobre les persones més pobres i va augmentar tant el nombre de factures emeses com el seu valor. Finalment, el darrer assaig tracta de l'ús d'incentius monetaris a través del projecte *Receita Certa*. Adreçada al sector del comerç, aquesta iniciativa ofereix com a recompensa la devolució d'una part de l'impost de consum als ciutadans. Aquest estudi avalua els impactes de *Receita Certa* mitjançant un model de diferència en diferències. Les variables de resposta són el nombre i el valor mensual de les factures electròniques emeses als beneficiaris. Perquè es produeixi el reemborsament, els ingressos del sector comercial han de superar la inflació. Els resultats mostren que el dret d'ingressos és ineficaç, ja que redueix el nombre de documents fiscals emesos i no és significatiu pel que fa al variable valor dels documents. A més, el cost de la iniciativa va ser elevat, fet que va posar de manifest la necessitat de revalorar el projecte. Els estats que registren un dèficit fiscal important han de millorar els seus sistemes de control. Iniciatives com les que es presenten en aquesta tesi pretenen implicar els contribuents en la lluita contra l'evasió, unes amb més èxit que d'altres. L'objectiu d'aquests estudis era contribuir a millors polítiques públiques en l'administració tributària.

Paraules clau: Evasió fiscal. Innovació. Govern digital. Economia del comportament. Panell Diferències en diferències.

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1 INTRODUCTION

We live in the age of information and the intense use of data to address economic and social problems. The government's mode of operation, as a rule, follows with a little delay the incorporation of services, methods and innovation tools that are made available to the public, even though in many cases the government itself is the financier of their creation. The demand for digital services has become increasingly relevant in our society, posing significant challenges for service providers, particularly in the public sector. There has been a prevalent notion suggesting that the private.

Mazzucato (2021) argues that the role of governments should not be limited to reactively fixing market issues, but actively structuring them to deliver the outcomes expected by society. In her view, the public sector has not been passive throughout history. This is the case of *Rio Grande do Sul* State, where the government search to support new actions and new products. The State is well known for their innovation parks like *Tecnopuc* and *Tecnosinos*, both already considered the best technological parks of Brazil, and the birthplace of great entrepreneurs. Usually perform as fifth economy of Brazil with a GDP similar to countries as Ecuador and Angola.

In this scenario the tax administration of *Rio Grande do Sul* is still an innovative player. In the context of Brazilian tax administration, there are many examples of processes that create value for citizens. One of them is the Brazilian digital-invoice system, which has existed for over a decade and has brought significant benefits to companies, the State, and consumers. This innovation represented a shift from an essentially analog model to a digital one, and *Rio Grande do Sul* state play a significative role in this process, and still is a major depository and datacenter to issue *fiscal* invoices to 21 states of Brazil.

This is a thesis about assessment of innovative public policies applied on tax administration of *Rio Grande do Sul* State in the last period, that address important issues in tax compliance and tax education in indirect taxation. The findings could serve as an important subsidy for improve tax administration worldwide. The thesis is presented in a form of compendium of articles.

The literature explore are indirect taxation and economic behavior. Both are presented as reviews in each article.

The challenges in tax administration in countries like Brazil where indirect tax are broadly use, happen in a context of informality and significant tax gap. Many solutions try to address the problem.

When implementing public policies, one of the relevant errors refers to the issue of focusing. Barreix et al. (2012) point out that the inclusion error can extend benefits to groups that have the highest income in society, and this inclusion error configures a focusing error.

Some studies have addressed the efficiency of the option to exempt items from the basic food basket as a way of mitigating the effects of regressive taxation. In 2018 and 2019, the Federal Government published two bulletins on the subject (Ministry of Economy 2019; Ministry of Finance 2018). It should be noted that the basic food basket exemption policy does not distinguish tax benefits by income level or type of food purchased, despite prioritizing low-income people who are more vulnerable to food insecurity and nutrition (Ministry of Economy 2019). The basic food basket exemption adopts as a premise the hypothesis that the exemption would be passed on completely to the final prices of the contemplated products. However, this measure may not be effective in many situations, since the process of price formation in the economy depends on different market structures, among other factors.

A great advantage of personalized VAT is that it tends to reduce tax regressivity, which ends up cooling the efficiency versus equity debate (da Silva 2017). However, the viability of a proposal will depend on the country's, or subnational's, poverty conditions, as well as on the funding sources and technical implementation conditions.

Regarding the use of public policies based on consumption taxation, it is worth highlighting the solutions adopted in Japan and Canada, which are similar to the *Devolve-ICMS* Program implemented in *Rio Grande do Sul*. Despite the similarity regarding the tax refund to poorer people and families, it is important to highlight the profound differences between these countries regarding the importance of value-added tax (VAT). These two countries are among those that collect the least VAT as a percentage of their GDP and practice relatively low rates. (OECD 2022).

In support of understanding behavior, Fehr et al. (2015) present a matrix (Behavioral Change Matrix) based on empirical research that shows that contributions to the public good depend on two interconnected conditions: awareness of a social norm to contribute (awareness) and the consequences of not following this norm, and willingness to contribute (willingness). To induce or educate people's behavior, many measures can be used: monetary incentives, fines, legal punishments, educational measures, and nudges. These measures, and others, can be effective, but their effectiveness will depend on specific contexts, social norms, and

individual characteristics of the target population. According to Fehr et al. (2015), awareness, or knowledge, of the effects that one's behavior has on other people can have a major impact on one's decisions. However, empirical evidence indicates that people often have little or no knowledge of whether their behavior influences other people and society positively or negatively. For instance, when someone litters in a park, it might encourage others to do the same. Similarly, evading taxes or not asking for a receipt may discourage others from adhering to this behavior.

In many situations, raising awareness alone is not enough to motivate behavioral change. Disposition can support the process of behavioral change, and it is influenced by several factors, including social norms, perceptions of fairness, reward or economic costs, and individual behavioral preferences. Economic incentives can affect willingness. People are aware of the problem but are not willing to change their behavior. Incentives, whether positive or negative, plus belief management, can be appropriate tools to resolve this situation.

The general consensus is that monetary incentives lead to greater effort than would otherwise occur. Some theories advocate that monetary incentives can lead to decrease in effort and performance. According to Deci and Ryan (1985), much research shows that monetary rewards decrease people's intrinsic motivation and also that observers infer less intrinsic motivation in people who are paid for an activity. For the authors, events such as choice and positive feedback have informative meaning and increase intrinsic motivation. For Costa et al. (2022), tax evasion continues to be a relevant problem in Brazil and worldwide. They emphasize that behavioral economics has sought to understand behavior by carrying out experiments on individuals' decision-making processes.

Over time, the risk aversion of taxpayers is mitigated probably by strengthening trust in the government service, by understanding that its use did not present an excess risk of audit and invasion of one's privacy.

All articles in this thesis rely on data from the electronic invoice collected in *Rio Grande do Sul* Tax agency. And specially in data where the taxpayer identified himself at the time of issuing the invoice with his tax number.

The methodology to analyze the innovations were based in the difference-in-differences (DID) model. This approach is one of the most used when the objective is to measure the impacts of social policies or programs (Angrist and Pischke 2014; Ryan et al. 2015). The main advantage of this method over the others is that it allows the control of the differences between the analyzed units, including over time. This increases confidence that the results achieved are specifically due to the analyzed program.

However, in the first article a new approach was given. How the data indicated significant fluctuations over time a method of identifying multiple structural breaks was employed. The method by Bai and Perron (1998) represents an important evolution in relation to other tests, which is to test multiple structural changes. The authors presented a method that identifies multiple structural changes, which occur at unknown dates, using a linear regression model estimated by least squares. Its main advantages are related to the properties of the estimators, the estimates of break dates and the construction of tests that allow for inferring the presence of structural changes and the number of breaks. Subsequently, econometric models are estimated to ascertain the effects of these changes. Clements and Hendry (1996) emphasize that forecasting analyses that assume a constant and time-invariant data generation process, which thus implicitly rule out structural or regime changes in the economy, overlook a significant aspect of the real world and consequently generate inaccurate forecasts.

There are very few empirical studies on the behavior of taxpayers and their interaction with public policies. This thesis seeks to add to the economic literature results found and conclusions from specific programs that are in full use.

In addition to this Introduction, Chapter 2 is focus on the innovation of the *Menor Preço Brasil* application. Chapter 3 elucidates the *Devolve-ICMS* program. Chapter 4 evaluate the *Receita Certa* project. The final Chapter presents the studies' conclusions.

More broadly, questions regarding the impact of COVID on the use of technology appear, present in the first article, which aims to verify the impact of the COVID-19 pandemic on the use of the *Menor Preço* Brazil app service. In the second article, the issue of reducing the regressivity of indirect tax (ICMS) and the capacity of the evaluated program to engage the beneficiary citizen in the fight against tax evasion arises. And finally, in the third article, the impact of a broad cashback conditional on the increase in revenue in the commerce sector is analyzed. In all of them there is a common presence of innovation and taxpayer behavioral analysis in engaging in tax compliance.

2 THE IMPACT OF THE COVID-19 PANDEMIC ON THE USE OF THE MENOR PREÇO BRAZIL APPLICATION

Administrative Sciences 2023, 13 (11), 229; <https://doi.org/10.3390/admsci13110229>
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Abstract: The *Menor Preço* Brazil application, based on a version developed in the state of *Rio Grande do Sul*, was launched in 2019 with the aim of expanding digital services to citizens. This application provides information on the nearest establishments and their product prices based on issued invoices. With the advent of the COVID-19 pandemic, this application adapted its service to facilitate access to prevention products. We are not aware of any other similar government application that uses individual invoice data to support citizens in finding products closer to them at better prices. This study aims to verify the impact of the COVID-19 pandemic on the use of the *Menor Preço* Brazil app service. To this end, it investigates both the correlation between confirmed cases of COVID-19 in Brazil and the changes in the application's functionalities with the variation in citizens' queries to the application. It is a quantitative approach. For this purpose, Bai and Perron's method of identifying multiple structural breaks and regression models are employed. The results indicate five structural breaks in the number of queries to the application, and that a 1% increase in COVID-19 cases led to a 0.2% increase in queries. These results confirm that user behavior related to the *Menor Preço* Brazil application was influenced not only by changes in the number of confirmed COVID-19 cases but also by those in the app's features and inflation rates. The literature also tends to consider the relevance of the relative effects of risk aversion on behavior, especially in the relationship with the tax authorities. This study reinforces the position of the initial relevance of risk aversion and when trust gradually strengthening the aversion to losses diminishes. The public sector has progressively increased the availability of digital services over time, and the results of this study underscore their significance in coping with extreme situations, such as pandemics, natural disasters, and other challenges to accessing goods and services.

2.1 INTRODUCTION

The demand for digital services has become increasingly relevant in our society, posing significant challenges for service providers, particularly in the public sector. There has been a prevalent notion suggesting that the private sector does generate value, asserting that value

creation is solely the responsibility of this sector and that it should only intervene in cases of market imperfections, and only if such interventions do not lead to even greater distortions.

This perspective about the public sector was contested by Mazzucato (2021), who argues that the role of governments should not be limited to reactively fixing market issues, but actively structuring them to deliver the outcomes expected by society. In her view, the public sector has not been passive throughout history, and she provides examples of innovations created by American agencies in co-participation with the private sector. Many current day-to-day technologies would not exist either because of risk/return or financing volume issues.

According to Gu et al. (2021), the spread of the COVID-19 pandemic and the growing importance of e-commerce have made the study of online consumer behavior increasingly relevant. Their research focuses on the shifts in online consumer behavior in the context of the COVID-19 pandemic. They argue that consumer awareness and experience have become more impactful, leading online consumers to be savvier in their purchasing decisions. They also note the growing importance of speed in consumer decision making. Drawing on a review of the contemporary literature, Gu et al. (2021) identified the main areas of research in online consumer behavior, which include marketing, consumer characteristics, social determinants, and other factors.

The relationship between the government and citizens in the digital economy is not widely understood, which makes this study particularly relevant. As the digital economy continues to accelerate, both governments and companies must focus on enhancing digital capabilities while seeking to build trust. Freeguard et al. (2020) reported the factors that contributed to the successes and failures of digital government during the pandemic. The authors put emphasis on transparency about use of personal data and new technology as algorithms, to avoid public concern about their use by government. Much more information about data sharing agreements and how our information flows across government should be published. The openness would also help a better collaboration between different departments.

A study by Zolkepli et al. (2021) explored perceived consumer values in mobile app behavior and investigated whether app cost and rating influence behavior. He confirmed that usage is influenced by rating and cost to some extent. The study suggests that users attribute greater value and rating to apps that are trending and are also willing to pay for higher-rated apps. The users are not in favor of analytical or complicated apps.

The App *Menor Preço* Brazil¹ is free, and the rating is 3.1 in google play and 2.5 in the Apple store. So far, there have been more than 100,000 downloads.

A study by Alavi and Buttlar (2019) highlights the detection capacity of smartphones and their crowdsourcing power to monitor several different civil infrastructure systems. The collection of multisensory information via smartphones can be a differentiator in decision making in smart cities. This is based on the active collaboration of citizens.

A study by Tandon et al. (2021) on consumers' behavioral responses when using food delivery applications (FDAs) found that visibility acted as an antecedent of all consumption values and significantly influenced purchase intentions.

Muangmee et al. (2021) investigated the factors that influenced the behavioral intention to use food delivery apps during the COVID-19 pandemic, a time when online transactions were viewed as important for preventing the *virus's* spread. Their findings indicated that performance expectancy, effort expectancy, social influence, opportunity, task technology suitability, perceived trust, and perceived security all significantly affected behavioral intention to use food delivery apps during the pandemic.

Considering the increase in mobile transactions replacing offline payments as a social distancing measure in the times of the pandemic, and therefore also a protective measure against any other outbreaks, Sreelakshmi and Prathap (2023) examined how the perceived health threat posed by COVID-19 and mobile-payment-service quality influenced consumers' perceived value of the continued use of mobile payment services in India. The study was based on customers who used mobile payment apps to make cashless transactions during the pandemic. It was found that the perceived susceptibility and perceived severity of COVID-19 significantly improved consumers' value perceptions regarding mobile payment services, which led to satisfaction and intention to continue using it.

Zhou et al. (2021) showed a brief survey of some mobile apps for COVID-19 that were implemented during the pandemic. They also mentioned the important role of Alipay and WeChat in China, or Aarogya Setu in India, among others. Their study also carried out interviews with healthcare and public safety experts to understand how mobile applications were used in China's response to COVID-19. Four relevant themes were mentioned: personal privacy, community involvement, government involvement, and situational specificity. They found that a great concern was maintaining a balance between collecting and utilizing personal information while also protecting this information. The most valuable feature of the mobile apps is information and data.

Islam et al. (2020) studied mobile applications developed for the COVID-19 pandemic. The apps were selected in the popular application stores; at the beginning there were 189 apps, but many were excluded for different reasons. By the end, 25 apps were analyzed regarding

their functionalities, user ratings, and user reviews. The majority of the analysis was about its current status and statistics from a local and global perspective (18), followed by the population aware of it (17), and the services it provided for the prevention of COVID-19 (15). The study provides design recommendations for future apps. According to the authors, the applications should provide quick and accurate responses, and should be usable, useful, responsive, flexible, and reliable. The apps should perform well, and security and privacy issues should be addressed properly. Finally, the application should be culturally sensitive.

Looking at cutting-edge knowledge, Kumar et al. (2023) reviewed the literature on IoT-assisted COVID-19 investigation to extensively examine the technological impact and the outbreak. The authors identified crucial domains where IoT-assisted technology has proven effective in combating the pandemic but has also improved traditional healthcare systems. The findings of this study revealed that blockchain technology, deep learning techniques, and digital twin technology were the latest trends in COVID-19 research. The limitations to the adoption of these technologies were data availability and quality, ethical concerns, regulatory barriers, and the digital divide. The research highlights the critical need for interdisciplinary collaborations. Vaishya et al. (2020) reviewed the role of Artificial Intelligence (AI) as a decisive technology to analyze, prepare and fight COVID-19. For the authors, this technology plays an important role in detecting the cluster of cases and to predict where this virus will affect by collecting and analyzing all previous data. AI works as a mimic of human intelligence. The significant applications are applied to track data of cases.

In the context of Brazilian tax administration, there are examples of processes that create value for citizens. One of them is the Brazilian digital-invoice system, which has existed for over a decade and has brought significant benefits to companies, the State, and consumers. This innovation represented a shift from an essentially analog model to a digital one. These digital invoices have enabled the development of new products and services, including the *Menor Preço* application, launched by the government of the state of *Rio Grande do Sul* in 2019. Later that year, the application was extended to other Brazilian states under a cooperative agreement and renamed *Menor Preço* Brazil. In the context of the COVID-19 pandemic, this application played a crucial role by enabling citizens to compare product prices, thereby informing their online or in-person shopping decisions. By using the application, citizens could find needed products at lower prices and in nearby locations, reducing the risk of disease contagion and transmission.

The general objective of this study is to analyze the impact of COVID-19 on the use of information technologies. In more specific terms, this study intends to evaluate whether changes

in the number of people infected by the virus influenced the use of the *Menor Preço* Application. The hypothesis is that in the most serious moments of the pandemic, the use of the application increased due to legal restrictions on circulation or even due to the individual fear of leaving home. This type of study is relevant, as its results can help to formulate both new communication strategies and new services provided by public authorities to citizens in other risk situations, such as weather alerts.

This study examines whether the behavior of the *Menor Preço* Brazil application's queries, carried out by citizens, correlated with changes in the number of confirmed COVID-19 cases in Brazil between 1 January 2020 and 28 December 2022. For this purpose, initially, Bai and Perron's (1998) method of identifying multiple structural breaks is employed. Subsequently, econometric models are estimated to ascertain the effects of these changes. Two models are generated: one without the structural breaks, and another incorporating the identified breaks. While the public sector has increased the availability of digital services over time, thus facilitating citizens' accessibility, it is important to analyze their usefulness and importance in extreme situations, such as pandemics, natural disasters, physical-mobility restrictions, and challenges to accessing goods and services. Among these, natural disasters have become increasingly frequent.

In addition to this Introduction, Section 2 details the features of the *Menor Preço* application. Section 3 elucidates the context of behavior economics within which this article should be understood. Section 4 outlines the methodological procedures employed in the study. Section 5 analyzes the results obtained. The final section presents the study's conclusions.

2.2 THE DIGITAL GOVERNMENT AND THE *MENOR PREÇO* BRAZIL APPLICATION

In response to the passive and risk-averse nature of public service, many public administrations have undertaken modernization initiatives, introducing digital services. Despite the widespread proliferation of internet access and new technologies in recent years, many public services remain mired in disconnected, slow, and inefficient procedures (Borges De Carvalho, 2020). Digital government initiatives demand a cultural change in public management. According to Borges De Carvalho (2020), citizens expect a level of service similar to what they encounter on private digital platforms. However, the public sector is more complex due to strict procedural regulations. Since the 1990s, public administration has undergone considerable changes, gradually incorporating information and communication technologies into processes, culminating in what could be termed electronic government. Its

main feature is the improvement in internal work processes, without changing its logic or compromising its citizen-centric focus.

Legal frameworks have also evolved in step with digital government. In the past 20 years, noteworthy developments include the introduction of the Digital Government Portal in 2000, the Transparency Portal in 2004, the Digital Inclusion Portal in 2006, the Access to Information Act in 2011, the institution of the National Electronic Process, and most recently, the inauguration of portal GOV.BR in 2019, which consolidated all digital channels of the Federal Government (Cristóvam et al. 2020).

The trend involves continuous technological advancement and digital improvement within the public sector. When public administration formulates its development plans and administrative systems based on technological advancements, it becomes part of what is known as the 4th Industrial Revolution (Industry 4.0). This tends to steer public authorities towards a perspective of Public Administration 4.0 (public management 4.0). However, this concept seems somewhat distant from the reality of Brazilian public administrations (Cristóvam et al. 2020).

It is important to point out that services should strive for universality, yet Brazil faces restrictions on access to information and services due to its socioeconomic characteristics. A survey conducted by the Brazilian Institute of Geography and Statistics (IBGE, 2018) addressing internet access, television, and mobile phone ownership revealed that home internet usage has risen rapidly in recent years, reaching 74.9% in 2017. Among households without internet, the main reasons were a lack of interest (34.9%), prohibitive costs (28.7%), and a lack of knowledge on how to use the internet (22.0%). Considering age demographics, only 31% of people over 60 used the internet.

As part of the transition to digital government, there is a need for administrations to shift focus from automation and cost reduction associated with e-government, towards fostering co-creation with citizens and companies. This moment of maturation of technologies and their governmental application signals the transformation toward a digital government that engages in a dialogue with citizens. The citizens participate in the creation and receipt of services, grounded in a government of open data, while maintaining data security (Aguilar Viana 2021). Creating public value through digital government is no longer optional. Digital services must align with citizens' perceptions. However, the concept of public value is still incipient in public services provided by governments (Lopes et al. 2018).

Adjusting to new changes within organizations can be difficult for several reasons, including complacency, attachment to old methods, current and future expectations, fear of

change, and cognitive dissonance. These factors can render the process challenging (Hubbart 2023).

According to Mazzucato (2018), public institutions must participate in the upcoming transformations, such as climate issues, an aging population, and the need for infrastructure and innovation. This author emphasizes the need to overcome the fear of failure and to realize that experimentation and the trial-and-error method are part of the learning process.

Mazzucato and Kattel (2020) argue that governments, to manage a pandemic, need dynamic capabilities that are often absent, such as the ability to adapt and learn, to align public services with citizens' needs, and to govern data and digital platforms.

For Agostino et al. (2021), when an onsite public service cannot be provided, it must be delivered online, relying on the available digital technology. The authors discuss the digital acceleration that governments and organizations have faced during the pandemic, with focus on 100 Italian state museums. The study showed how digital technologies and social media can be a powerful tool, helping new ways of service delivery, for example broader audiences and new ways of interacting with users.

Gertler et al. (2018) provided elements for policymakers and program managers to consider impact evaluations as part of a change theory. This theory should clearly define the causal mechanisms through which a program works to produce and influence outcomes. They emphasize the importance of combining impact assessments with monitoring and supplementary evaluation to obtain a comprehensive view of the results.

Within this context, the State Revenue Department of *Rio Grande do Sul* created an application allowing citizens to search for the lowest-priced products, backed by invoices. The *Menor Preço* application enables users to find the lowest prices of a product in over 300,000 establishments in the state, including stores, pharmacies, gas stations, supermarkets, etc. This innovation empowers citizens to save money and avoids unnecessary travel. The application uses the user's location to find the lowest prices and closest establishments (refer to Figure 1).

Figure 1: Fastest route (a); gasoline price history (b); and shortcut to COVID-19 prevention items (c)



Source: Direct in-app search.

The *Menor Preço* application allows users to filter by distance, showing a list of product prices, points of sale, the time of invoice issuance, and the issuer. Users can call the indicated location to check product availability. The application shows the store's prices over the last seven days and compares them with those of neighboring stores. After choosing a store, users can use navigation features to reach it. The search limit covers a maximum radius of 30 km, with a default setting of 5 km, and users can also share their searches.

Prices are updated in real-time based on the values from Electronic Invoices (NF-e) and Consumer Electronic Invoices (NFC-e). The database includes only invoices associated with a CPF (*Cadastro de Pessoas Físicas*, Brazilian Individual Taxpayer Registry), which promotes tax compliance and encourages citizens to contribute to the shared database. The buyer's identity remains confidential. This is an important point because it is a collaborative tool, where the more citizens that demand the inclusion of their identification in the invoice, the larger the application database will be, and this will bring more price and establishment options to other citizens.

Regarding *fiscal* education, Souza and Souza (2018) support the hypothesis that changing the patrimonial culture and the invisibility of the tax system's role in citizens' lives involves knowledge about tax education being conveyed and applied to everyday life.

In the last months of 2019, the National Council for Finance Policy (*Confaz*), along with the federative units, approved the creation of the *Menor Preço* Brazil application, leading to the signing of a related agreement (Brazil 2019). This application was launched in December 2019, and by 2022, it had accumulated more than 44 million searches. In January 2020, the application recorded 197,000 queries, which increased to 1.174 million in April amidst the COVID-19 pandemic.

A special COVID-19 version of the application was launched in March 2020, at the onset of the pandemic, providing a shortcut to disease-protective items such as masks, gloves, and hand sanitizer. This version removed the need for CPF registration and password use, thereby allowing any citizen to use the tool during this difficult period. However, the average number of queries dropped from 1.2 million in 2020 to 745 thousand in 2021 because of the mandatory login with CPF, leading to a sharp drop from 2.4 million per month to less than 300 thousand in December 2020.

This fact demonstrates a reluctance among citizens to provide identification. This drop in the number of queries following the introduction of the CPF requirement gives us a glimpse into the behavioral obstacles that inhibit the exercise of tax citizenship by including the consumer's CPF on invoices, which are, as a rule, much greater. With the application's update in November 2020, which mandated logging in through a GOV.BR account, which is a means for users to access digital public services, these barriers were heightened. The unified login, used by several applications and services such as the digital CNH, INSS services, and TSE biometric voting, contributed to the initial drop in queries.

However, there was a gradual recovery in the use of the *Menor Preço* Brazil application from month to month in 2021 and 2022. In 2022, the monthly average number of queries reached 1.7 million, exceeding the 2020 level. The peak monthly usage so far occurred in August 2020, with 2.57 million queries. The *Menor Preço* Brazil application, by removing the CPF requirement for consultation, eliminated an important mental barrier to its use. The urgency of the pandemic encouraged its usage, as the application identified where and at what price products were available, thus minimizing unnecessary travel and reducing contagion risk. However, when the CPF requirement was reintroduced in November 2020, there was a sharp drop in usage. This reflects the reappearance of mistrust, causing a cost-benefit analysis to occur in the user's mind.

The return of the requirement to use identification to access the application in November 2020 was probably caused by the notion or desire that the end of the pandemic was near. However, it was at a time when the second wave of COVID-19 was flourishing. In the citizen's relations with the tax authorities, the power of an empire is always present, along with the fear that the information collected could affect not only privacy but could also be used in tax audits. So, aversion to these risks will always be present in some way, probably more intense or not depending on the degree of transparency.

In addition to this application, the State Revenue Department has developed a series of innovations, including the *Devolve-ICMS* Program, whose impact assessment was reported in

Tonetto et al. (2023), and the *Receita Certa* Project. Both initiatives involve digital invoices and *fiscal* education.

2.3 BEHAVIOR ECONOMICS

Behavioral Economics (BE) is a recent 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 behavior.

Varian (2010) argues that BE focuses on the study of consumer choices, employing psychological insights to predict people's decisions, many of which diverge from the conventional economic model's assumption of consumer rationality.

Samson, on the other hand, defines BE as the study of cognitive, social and emotional influences economic behavior. This field primarily employs experimentation to develop theories about human decision making (Avila and Bianchi, 2015; Samson, 2014).

DellaVigna (2009) suggests that this research area identifies three significant deviations from the standard model: (1) nonstandard preferences, (2) nonstandard beliefs, and (3) nonstandard decision making. He presents empirical evidence from several applications, ranging from consumption to finance, and from crime to voting. This author discusses time preferences, self-control problems, risk preferences, and social preferences. Regarding nonstandard decision making, he points out menu effects, social pressure, and emotions.

In BE, decisions are shaped by habits, experiences, and heuristic rules. Satisfactory solutions are accepted, and not maximization ones. It recognizes that it difficult to reconcile short- and long-term interests and that decisions are strongly influenced by emotional factors and interactions with other decision makers (Avila and Bianchi 2015).

The experimental method is the primary tool that behavioral economists use for empirical investigation. Despite initial opposition from scholars such as John Stuart Mill and Milton Friedman to applying this method in the social sciences, BE and its research methodologies have gradually developed and gained academic recognition (Avila and Bianchi 2015).

Experimental economists began to analyze how humans behave when sharing an amount of money with anonymous partners. This practice enabled the detection of unexpected and unusual responses in human behavior, as viewed by microeconomic theory. Currently,

these experiments have transitioned from the laboratory to real-life settings, with the aim of reproducing more reliable conditions.

BE started in the 1930s and was devoted to experimentally determine individual indifference curves. The publication of Von Neumann and Morgenstern's book on Game Theory (GT) in 1944 was a great stimulus, establishing a close relationship between BE and GT. The first formulation of the prisoner's dilemma marked another key development (Bianchi and da Silva Filho 2001). The increase in natural experiments, largely carried out online, allows participants to remain unaware of their involvement in the study.

Recently, BE has started migrating from university laboratories to real-life contexts. In the public sector, the 'test and learn' approach enhances accuracy and reduces costs by focusing on policies that yield consistent results. Although Big Data solutions aim to identify patterns in vast datasets, they often rely excessively on correlation rather than causation. It is important to scrutinize these results critically, even if no substantive differences are found between studied groups, of the knowledge gained can be valuable for redesigning experiments.

Cleto (2019) observed a steady increase in the number of BE publications in the Web of Science database from 2000 to 2018. From a mere 10 publications per year until 2005, it surged to more than 100 annually from 2016 onwards. Most publications are from the United States (55%), followed by the UK and Germany, with approximately 10 and 6%, respectively, adding to 71% of all publications. The predominant language for publications is English, with approximately 96%.

It can be speculated that the notoriety achieved by Nobel Prize laureates like Daniel Kahneman and Vernon Smith, in 2002, Robert Shiller, in 2013, and Richard Thaler in 2017 significantly influenced this trend. Thaler's research advocates that people tend to simplify their financial decisions and do not always make rational choices.

In 2010, the UK government, with the aim of improving the efficiency and quality of public management, created an organization called the Behavioral Insights Team (BIT), also known as the Nudge Unit. Today, BIT has disseminated studies to several countries (Feitosa and Cruz, 2019; Meneguín and Ávila, 2019).

In behavioral analysis, a series of circumstances and aspects directly influence or even define behavior. Ariely (2020) provides a simple example of inappropriate behavior often exhibited by drivers—texting while driving. This behavior greatly increases the risk of traffic accidents, causing harm to oneself and others, and potentially resulting in fatalities. It represents an action that contradicts our long-term interests.

On the other hand, the economic world seeks our immediate attention and money, not necessarily our well-being 20 years from now. Some studies indicate that half of the deaths among adults aged 15 and 64 in the United States are caused or influenced by poor personal decisions, usually associated with physical inactivity, drug use, and smoking, among other factors. If people were 100% rational, they would simply need to be provided with the necessary information and they would make the right decisions. However, the behavioral approach demonstrates that this is not how things work. The information is not always fully available or presented in a way that promotes understanding, and our capacity to evaluate is also limited and conditioned—an idea encompassed in the concept of bounded rationality.

There are many behavioral biases and two blind spots: the belief in consumer and market rationality. Usually, the analysis of concrete phenomena dispels these beliefs. Our choices are often made automatically, rather than through careful deliberation. Many BE approaches supplement the rational choice model. These include the Prospect Theory, Bounded Rationality, Dual System, and Social and Temporal Dimensions (Avila and Bianchi, 2015).

According to Kahneman and Tversky (1979), and the Prospect Theory, decisions are not always optimal. Our willingness to take risks is influenced by the way choices are framed, that is, how they are presented to us. The context in which choices are made will influence the decision. The presentation of choices as either wins or losses will influence the response. Kahneman and Tversky (1979) also presents a critique of utility theory in relation to decision making under risk. According to the authors, people underestimate merely probable results in relation to results obtained with certainty, generating a certainty effect that contributes to risk aversion in choices that involve certain gains and to the search for risk in choices that involve certain losses. Tversky and Kahneman (1974) describe heuristics that are employed to make judgments under uncertainty. One of them is anchoring, which is normally employed in numerical prediction when a relevant value is available. These heuristics are highly cost-effective and generally effective, but they lead to systematic and predictable errors. A better understanding of these heuristics and the biases they lead to can improve judgment and decision in situations of uncertainty.

Tversky and Kahneman (1991) explain that trade can involve two dimensions, and loss aversion may operate in both. In the case of loss aversion for the good, the owner will be reluctant to sell; conversely, if the buyer perceives the money spent on the purchase as a loss, there will be reluctance to buy. These two effects can be estimated by comparing sellers and buyers to a chooser who has a choice between the good and the money, where there is no loss aversion.

Bounded rationality acknowledges the limitations of information and processing, leading to decisions that are not always optimal. This approach confronts us with heuristics and biases, simple but effective algorithms that can lead to near-optimal results. Kahneman (2012) suggests that making quick decisions is effective when the likelihood of correct conclusions is high, and the cost of an occasional error is acceptable. However, it becomes problematic in unfamiliar situations, where the potential loss is significant, and there is insufficient time to gather more information.

According to Thaler (1999), mental accounting influences choice. This process comprises a set of cognitive operations that individuals and families employ to organize, evaluate, and monitor their financial activities.

According to Fehr et al. (2015), behavior is shaped by two interconnected elements: willingness and awareness. In the *fiscal* context, monetary stimuli represented by prizes and draws, as in the state of *Rio Grande do Sul*, can motivate taxpayers to include their CPF in the invoices and boost the tax citizenship program. In terms of awareness and education, applications such as the *Menor Preço* Brazil can effectively engage citizens.

When Value Added Tax (VAT) was introduced in Europe, awareness of the effects of excluding some items from full taxation, and policymakers, relied on intuition. It seemed logical that essential items should not be taxed, and it was believed that the natural regressivity of a general consumption tax could be lessened by excluding these items from total taxation. Evidence shows that tax cuts are often not fully passed on to consumers, and wealthier households benefit the most when they are. Although tax policy experts have highlighted many of these concerns for decades, resistance to broad-based VATs surprisingly persists. In public opinion, there is a backlash to reforms that is permeated by a variety of cognitive biases, including cognitive dissonance and loss aversion (de la Feria and Walpole, 2020).

According to Costa et al. (2022), the application of BE-based interventions designed to draw attention to moral standards for tax compliance can be effective, notably in cases where dishonesty does not arise from rational motivation. They emphasize that the mind's interpretation of heuristics depends on understanding the context in which they are used. For these authors, individuals with higher property or income may be less sensitive to treatment due to lower risk aversion. Risk aversion varies among individuals.

Feitosa and Cruz (2019) advise that when implementing incentives for taxpayers, it is important to avoid triggering aversion to state control and disengagement. An experiment with taxpayers in Minnesota found that when taxpayers are aware that compliance with the law is high, they become less likely to evade tax authorities.

Fostering desirable behaviors is possible, according to Sunstein and Thaler (2019). Governments and tax authorities are increasingly engaging with taxpayers through automated income tax declarations, a trend that began in Nordic countries and has gained popularity elsewhere. Some countries even allow changes to tax declaration via text message, as noted by Sunstein and Thaler (2019). Trust gradually strengthens in relationships, and aversion to losses diminishes as a result of increased transparency.

According to Sunstein and Thaler (2019), loss aversion is well-documented, as exemplified by the case of donated coffee mugs where donors demanded significantly higher prices than potential buyers were willing to pay. It is worth highlighting that loss aversion leads to inertia, which can only be overcome by another influencing factor.

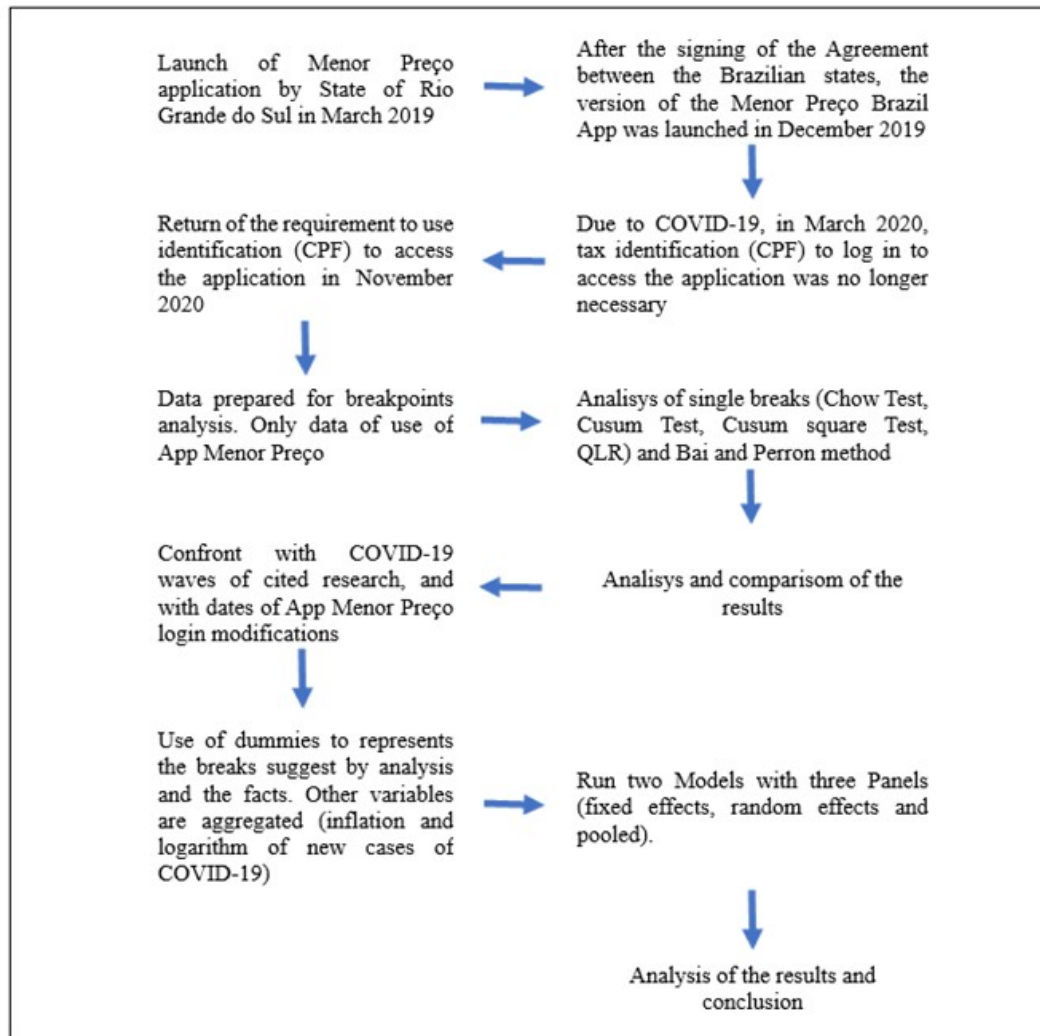
Empirical evidence suggests a potential role for behavioral factors in tax compliance analysis, with certain behavioral decision-making features possibly leading to greater tax compliance. For example, individuals may overestimate the likelihood of audits. Another influential behavior is social preference, which may lead individuals to comply with taxes at a higher rate than if they were solely driven by personal interest (Congdon et al. 2011).

2.4 METHODOLOGY

For Hendry (2000), in many situations of economic life, statistical tests are not necessary to distinguish between the conditions of 1899 and 1999. However, a series of parameter changes in econometric models cannot be easily detected by conventional tests, while some changes are manifest and easy to identify.

To achieve the objectives, an analysis of structural breaks in the number of queries made to the *Menor Preço* Brazil application is initially carried out. Subsequently, econometric models are estimated to ascertain the effects of these changes in the number of confirmed COVID-19 cases on the number of product price queries using the application. The identification of structural breaks enables the verification of whether there has been a shift in citizen behavior concerning queries to the application over the period analyzed. Consequently, it becomes possible to determine whether these breaks are associated with changes in the number of confirmed COVID-19 cases during the same period. Furthermore, these breaks are used as dummy variables in econometric models (Figure 2 shows the procedures of methodologic analysis).

Figure 2: Schematic illustration of the methods



Source: prepared by the authors.

When using regression models involving time series data, there may be a structural change in the relationship between the dependent variable Y and the explanatory variables. A structural change occurs when the model parameter values do not remain consistent throughout the period being analyzed. One of the many practical advantages of estimating and inferring models with structural changes is that it allows for the identification of events that may have induced these structural changes. Consequently, this enables a comparison between the estimated date of interruption and the effective date of a policy's implementation.

In the test carried out in this study, Y represented the number of price queries made through the *Menor Preço* application, 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 and Perron's (1998) method of identifying multiple breaks.

The Chow test checks for a structural break in a time series divided into two periods by comparing the regression coefficients between these periods and testing the hypothesis that they are statistically equal. This test is applied when there are reasons to believe that the sample can be split into two sub-samples, each corresponding to different contexts. The CUSUM test tracks the cumulative sum of differences between the observed and expected values of a time series. If this sum reaches a certain critical value, it could indicate the presence of a structural break.

The test constructs significance bands so that the probability of crossing these bands is equal to the intended significance level. These significance bands are constructed along the lines. The CUSUM-sq test is based on cumulative sums of squares of recursive residuals. Dufour (1982) highlights that this test should essentially be considered as a heteroscedasticity test, indicating instability in variances. However, in terms of recursive residues, it could also suggest instability in the model's coefficients. Vasco (2002) outlines the two tests, detailing their characteristics and applications.

The QLR test, in turn, endogenously provides an estimate of the date of a structural break.

Feio et al. (2022), aiming to analyze the dynamics of the public debt from November 2002 to September 2020, employed the method of identifying multiple structural breaks. They discussed the evolution of Brazilian public debt and emphasized the importance of the structural break test, specially the Chow test, in macroeconomic analysis. This is a recent example of using structural break analysis in the realm of public finance.

For Bai and Perron (1998), the economic and statistical literature contains many studies on change or a structural break; however, it is designed for cases of a single break. The authors presented a method that identifies multiple structural changes, which occur at unknown dates, using a linear regression model estimated by least squares. Its main advantages are related to the properties of the estimators, the estimates of break dates and the construction of tests that allow for inferring the presence of structural changes and the number of breaks. Finally, the method by Bai and Perron (1998) represents an important evolution in relation to other tests, which is to test multiple structural changes.

Clements and Hendry (1996) emphasize that forecasting analyses that assume a constant and time-invariant data generation process, which thus implicitly rule out structural or regime changes in the economy, overlook a significant aspect of the real world and consequently generate inaccurate forecasts. Certain models can provide more robust protection against unforeseen structural breaks than others, and several techniques can further enhance the resilience of forecasting models.

In the present study, there is also exogenous information that indicates probable break dates. According to Lopes (2021), 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 any restriction. If the information is exogenous, it will not distort the dimension properties and is likely to yield a test with substantial power. However, the data may indicate a slightly different date. This discrepancy might arise because major adjustments or changes in conduct often do not coincide precisely with the date of institutional change.

Two important moments to consider are the dates when the requirement to log in to use the application was removed (29 March 2020) and reinstated (11 November 2020). The removal of the login requirement was implemented to facilitate the use of the application to foster online purchases and thereby reducing the risk of contagion in in-person transactions.

The focus of this research is not on analyzing the covariance of behavioral theoretical aspects, but rather on examining the influence of context.

Another important piece of information is the periodization of COVID-19 waves in Brazil. Moura et al. (2022) analyzed the temporal evolution of the contagion from the first reported case to 21 May 2022. According to their findings, the three distinct waves are evident: the first from 23 February to 25 July 2020; the second on 08 November 2020 to 10 April 2021; and the third from 26 December 2021 to 21 May 2022. Thus, it was expected that structural breaks would occur around these periods.

The dates of the breaks identified by Bai and Perron's method and their possible explanations are as follows on Table 1 and one detected using the Cusum-Sq test.

Table 1: Dates of breaks detected

Dates of breaks detected.		
Break/Method	Data	Justification
1 ^a Cusum-Sq	04 March 2020	First wave of COVID-19 and removal of login requirement
2 ^a Bai and Perron	15 June 2020	The week when the total accumulated cases surpassed 1 million
3 ^a Bai and Perron	27 November 2020	The date when the next login restriction for the use of the application was imposed, coinciding with the second wave of COVID-19
4 ^a Bai and Perron	20 June 2021	The date is two days before the peak of new cases up to that point in 2021, and it also marks the time when more than 500,000 new weekly cases were reported
5 ^a Bai and Perron	30 January 2022	The number of new weekly cases reached 1.3 million. On set of third wave of COVID- 19

Source: Prepared by the authors.

This date aligned closely with the onset of the first wave of COVID-19 and the removal of the login requirement for the use of the *Menor Preço* Brazil application. Chow's test was subsequently used and it confirmed the significance of these breaks.

We should consider that increased familiarity with the application likely contributed to a rise in app queries over time.

The data used for the analyses consisted of time series that represent the daily queries made to the *Menor Preço* Brazil application and the number of new daily confirmed COVID-19 cases in Brazil. The data for application queries were sourced from the Secretary of Finance of *Rio Grande do Sul*, while the data for confirmed COVID-19 cases were obtained from the Johns Hopkins Coronavirus Resource Center (CRC). The period analyzed ranged from 1 January 2020 to 28 December 2022. Table 2 shows the definitions of the variables used in the study, along with some descriptive statistics and their respective sources.

In summary, multiple breaks were initially estimated using the Bai and Perron's method. Subsequently, a regression analysis was performed between queries made to the application and the number of new daily COVID-19 cases. Finally, dummy variables representing the structural breaks found in the regression analysis were included. This was done to verify the possible associations between the dates. The following models were estimated:

$$LNAPP = \alpha + \beta_1 * LNCovid + \beta_2 * IPCA + \varepsilon, \quad (1)$$

$$LNAPP = \alpha + \beta_1 * LNCovid + \beta_2 * IPCA + \beta_3 * D1 + \beta_4 * D2 + \beta_5 * D3 + \beta_6 * D4 + \varepsilon, \quad (2)$$

where α and β are the estimated parameters and ε is the residual of the models. The other variables are defined in Table 2.

Table 2: Definition of variables and descriptive statistics

Acronym	Description	Minimum	Average	Maximum	Source
NAPP	Number of daily queries made to the <i>Menor Preço</i> Brazil application	326	40,913	327,200	Sefaz/RS
NCovid	Number of new confirmed COVID-19 cases in Brazil	0	33,197	287,100	CRC
LNAPP	Natural log of the number of daily queries made to the <i>Menor Preço</i> Brazil application	5.78	10.19	12.70	Sefaz/RS
LNCovid	Natural log of the number of new confirmed COVID-19 cases in Brazil	0.000	10.03	12.57	CRC
IPCA	Monthly consumer price index in Brazil	1.000	1.103	1.219	IBGE
D1	Dummy for the period 15 June 2020 to 26 November 2020	0.000	0.151	1.000	Bai and Perron
D2	Dummy for the period 27 November 2020 to 19 June 2021	0.000	0.187	1.000	Bai and Perron
D3	Dummy for the period 20 June 2021 to 29 January 2022	0.000	0.204	1.000	Bai and Perron
D4	Dummy for the period 30 January 2022 to 28 December 2022	0.000	0.304	1.000	Bai and Perron

Source: Prepared by the authors.

2.5 RESULTS AND DISCUSSION

From 30 December 2019 to 28 December 2022, the *Menor Preço* Brazil application logged a total of 44,718,086 consultations. At the end of 2020 and again in 2022, the most sought-after products were medicines and supermarket items. The system supporting the application does not keep records of product queries beyond the current month, which underscores the relevance of this study.

Table 3 shows some differences in preferences between Brazilians overall and Gauchos (citizens of the state of *Rio Grande do Sul*). In the case of *Rio Grande do Sul*, it is noteworthy that food items constituted 50% of the top 10, followed by alcoholic beverages at 30% and medicinal items at 20%. In contrast, medications dominating the searches in Brazil prevailed; if we characterize vitamin D supplements as medication, this type of item accounted for 70% of the searches. Interestingly, in the Brazilian context, cement topped the list, with tomatoes being the primary food item. The price of tomatoes has been a topic of much discussion throughout the year. It is also worth mentioning that, in the case of *Rio Grande do Sul*, “chester”—a Christmas-related item, and “*picanha*”—a famous steak, featured prominently on the list, underscoring regional preferences.

Table 3: Top ten items searched in *Menor Preço (Rio Grande do Sul)* and *Menor Preço Brazil* applications in December 2022

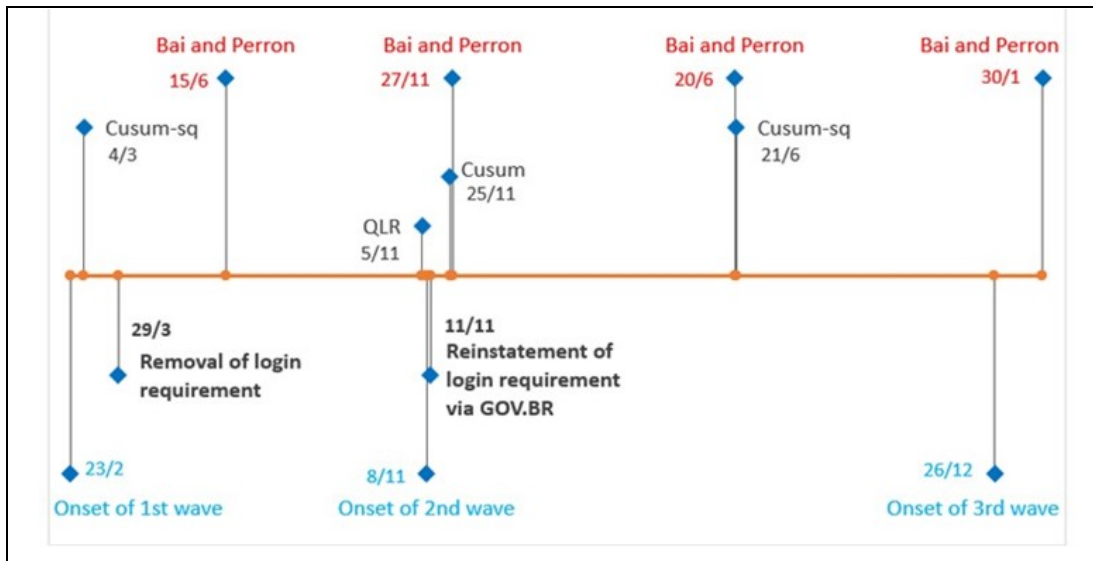
Item RS	Amount RS	Type RS	Item BR	Amount BR	Type BR
1	2366	Alcoholic beverage	1	6051	Building material
2	2109	Medicine	2	3448	Medicine
3	2083	Alcoholic beverage	3	2196	Medicine
4	1519	Food	4	1628	Medicine
5	1486	Food	5	1175	Alcoholic beverage
6	1458	Food	6	1017	Medicine
7	1425	Alcoholic beverage	7	960	Medicine
8	1309	Medicine	8	946	Vitamin
9	1211	Food	9	878	Food
10	1062	Food	10	872	Medicine

Source: SEFAZ RS.

In the analysis of the time series of queries to the *Menor Preço Brazil* application, Bai and Perron's method was used to analyze the time series of the queries made to the application. This was complemented by the CUSUM, CUSUM-sq, and QLR tests, which were validated using the Chow test. Exogenous events that suggest a structural break include the removal of the user identification requirements for queries and the reinstatement of the login according to the GOV.BR platform, both of which occurred in March and November 2020, respectively.

Figure 3 shows all the structural breaks found using statistical tests and exogenous event dates. Bai and Perron's method identified four structural break dates: 15 June 2020, 27 November 2020, 20 June 2021, and 30 January 2022. The CUSUM test indicated a break on 25 November 2020. The CUSUM-sq test pointed to two breaks: 4 March 2020 and 21 June 2021. The QLR test identified a break on 11 June 2020. The exogenous event dates—referring to the removal of the login requirement, the subsequent return of this requirement, and the three waves of COVID-19—were adequately captured by the statistical tests.

Figure 3: Timeline with exogenous event dates (below) and probable structural break dates according to the different tests (above)

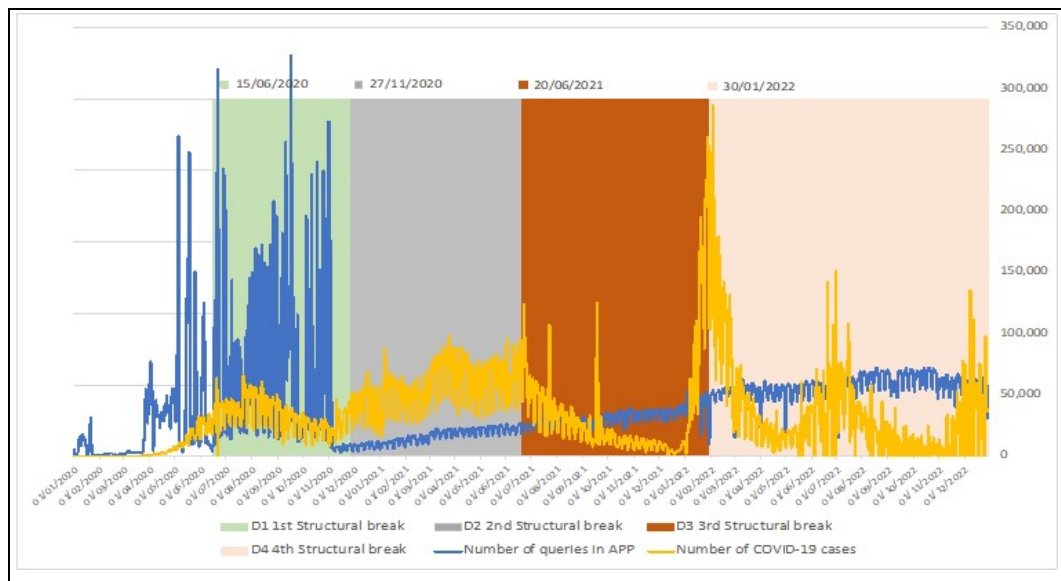


Source: Search results. Prepared by the authors

Note: Below are the start dates for the COVID-19 waves and changes to the way you log in to the application. Above dates indicate structural breaks using different methods.

Figure 4 shows that the removal of the login requirement for accessing the application on 29 March 2020 increased the number of queries; conversely, the reinstatement of the user identification requirement on 11 November 2020 led to a drastic reduction in the number of queries (indicated by the blue line). Some of the dates identified as breaks were similar across the different tests.

Figure 4: Queries made to the *Menor Preço* Brazil application and confirmed COVID-19 cases



Source: prepared by the authors.

Note: D1 to D4 are periods based on structural breaks points detected on method of Bai and Perron (1998) that became dummy variables in regression model.

Using the information on daily queries to the *Menor Preço* Brazil application, on confirmed daily COVID-19 cases, and structural breaks identified by the Bai and Perron's method (1998), two linear regression models were estimated according to Equations (1) and (2), as presented in the Methodology section. The results are in Table 4. The monthly IPCA inflation index was used as a control variable to capture the effect of prices during the analyzed period, which extended from 1 January 2020 to 28 December 2022. Although data collection on COVID-19 by the CRC commenced on 22 January 2020, the first case in Brazil was not reported until 26 February 2020. The CRC data series for Brazil continues until March 2023, and over 37 million cases were computed in this period.

The results presented in Table 4 show a convergence of signs for the *LNCovid* and *IPCA* dummy variables. However, in model 2, the constant became insignificant, indicating that the inclusion of structural break dummy variables in this model captures much information omitted in model 1. The larger R^2 also supports the improvement in the model's explanatory power when structural breaks are incorporated. Model 2, with the inclusion of structural break dummy variables, shows greater explanatory power, confirming the hypothesis that queries to the *Menor Preço* Brazil application were influenced by the increase in new daily COVID-19 cases. It was observed that a 1% increase in COVID-19 cases (*LNCovid*) resulted in a 0.2% increase in queries to the application.

The main control variable used in the model, inflation (IPCA), also positively influenced queries to the application. As anticipated, a 1% increase in the inflation index led to an 8.6% increase in the number of queries made to the *Menor Preço* Brazil application. A review of the table of descriptive statistics (Table 2) reveals that this was a time of high inflation, with the index accumulating to 21% over this period.

Three of the four structural-break dummy variables incorporated in the model were significant, thus validating the Bai and Perron test. The negative sign for these variables was expected, as the break indicates a shift in the trajectory of the variable of interest—in this case, the number of queries to the application (*LNAPP*). Moreover, a negative sign suggests that the break represents a peak in the number of queries. This peak, in turn, is associated with the events discussed earlier, such as waves of COVID-19 and the changes in the login requirement to access the application. Figure 3 shows that the dummy variable *D2* is associated with the second wave of COVID-19 and the reinstatement of the login requirement to access the application, whereas the dummy variable *D4* is associated with the third wave of COVID-19.

Table 4: Model results are estimated in robust form

Variables	Endogenous variable: Natural log of the number of queries made to the <i>Menor Preço</i> Brazil (<i>LNAPP</i>) application	
	Model 1	Model 2
<i>const</i>	4.4542*** (0.3855)	-0.3857 (1.4566)
<i>LNCovid</i>	0.1019*** (0.0175)	0.2026*** (0.0195)
<i>IPCA</i>	4.4052*** (0.3403)	8.6287*** (1.4203)
<i>D1</i>		0.0605 (0.1020)
<i>D2</i>		-1.3537*** (0.1417)
<i>D3</i>		-0.9578*** (0.2050)
<i>D4</i>		-1.0918*** (0.3040)
Observations	944	944
R^2 adjusted	0.1969	0.4076
<i>F</i> statistics	116.6000***	109.1000***

Source: Prepared by the authors.

Notes: *** indicate significance at 1%. The standard error is shown in parentheses.

2.6 CONCLUSIONS

This study aimed to describe and analyze the evolution of queries made by Brazilian citizens to the *Menor Preço* Brazil application over the last three years during the COVID- 19 pandemic. The application was adapted to respond to the pandemic and was made available without the need for a login, thereby enabling people to more easily find the products they were searching for, thus reducing the risk of contagion. The hypothesis of structural breaks was tested seeking to identify changes in citizen behavior over this period. To this end, the Bai and Perron, Chow, QLR, CUSUM, and CUSUM-sq tests were employed. The data used in the analysis were obtained from the Finance Secretariat of the State of *Rio Grande do Sul* and Johns Hopkins University.

In the usage of the *Menor Preço* Brazil application, five structural breaks were identified. These breaks were investigated by changes in the access to the application and fluctuations in the daily number of reported COVID-19 cases in Brazil. A regression model

confirmed the impact of new COVID-19 cases on the usage of the search application. A 1% increase in COVID-19 cases led to a 0.2% increase in queries to the application. Furthermore, a 1% rise in the inflation index resulted in an 8.6% increase in the number of queries to the application.

The empirical analysis confirms the impact of COVID-19 in the use of technology. The use of the application *Menor Preço* Brazil increased due to issues related to the pandemic in the form of legal restrictions on circulation or even due to self-restriction caused by fear of contamination when leaving home.

The theoretical approach revealed that initially, when the app did not require identification and there was no perceived risk of loss (BE), usage was high, spurred by the pandemic and inflation. However, when login requirements were introduced, concerns of loss aversion and increased tax scrutiny arose, as Congdon et al. (2011) announced, leading to a significant decline in usage.

The study proves that the risk of aversion was important at that time, but fortunately it was possible to overcome it (Feitosa and Cruz 2019; Costa et al. 2022; Sunstein and Thaler 2019). Over time, the risk aversion was mitigated probably by strengthening trust in the government service, by understanding that its use did not present an excess risk of audit and invasion of one's privacy, and by the urgency of the COVID-19 situation, where the benefits of using the app—such as time savings, lower prices, and reduced risk of contagion—became more apparent.

It is plausible that what Sunstein and Thaler (2019) refer to as 'herd behavior' may have occurred, as information about the app's usefulness spread among users.

The public sector has progressively increased the availability of digital services over time. The results of this study underscore their significance in coping with extreme situations, such as pandemics, natural disasters, and other challenges to accessing goods and services. Citizen responses to digital services can be immediate and have significant impact and value, as demonstrate by the data presented here.

Limitations of this study include the constraints of the available database, as it lacks records on federative units, user profiles, and the specific products being sought at the most granular level. Further studies can and should be carried out to understand more comprehensively citizen behavior concerning digital products and services.

This study demonstrates that digital solutions can significantly enhance citizens' daily lives. However, it is also crucial to monitor the impact and evolution of these solutions. The

study suggests that the login restriction imposed on the eve of the second wave of COVID-19 might have been avoidable if there had been proper data monitoring.

Notes

- 1) Link to download the *Menor Preço* application from the Apple store (also available for android): <https://apps.apple.com/br/app/menor-pre%C3%A7o-brazil/id1483644418>.
- 2) Data available at: https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_19_time_series/time_series_covid19_confirmed_global.csv

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3 REFUND OF CONSUMPTION TAX TO LOW-INCOME PEOPLE: IMPACT ASSESSMENT USING DIFFERENCE-IN-DIFFERENCES

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Abstract: One way to reduce inequality and poverty is to promote tax justice. In 2021, the government of the state of *Rio Grande do Sul*, Brazil, implemented a program (the *Devolve-ICMS* Program) that refunds consumption tax to low-income citizens (cashback). This study aims to evaluate the impacts of this Program using a differences-in-differences model and having, as response variables, the monthly sum of electronic invoices issued to the Program's beneficiaries, as well as their value. The database used includes all invoices issued to the target population during the 12 months before the Program's implementation and the 14 months after its implementation, resulting in 7.7 million records. To receive the tax refund, the eligible population must pick up a Citizen Card, made available by the state government, which was done by a significant part of this population. The treatment group is composed of eligible citizens who have the Card, whereas the control group comprises eligible citizens who do not have it. The results show that the Program is effective, as it has reduced tax pressure on poor people and increased both the number of invoices issued and their value.

3.1 INTRODUCTION

Brazil is a very unequal country, with high rates of poverty and labor informality. Using the World Bank's concept of the social poverty line, Bagolin et al. (2022) point out that the social poverty rate in Brazil reached 30.4% in 2021. Thus, 64.6 million Brazilians can be considered socially poor. Regarding labor informality, IBGE (2022) reports that there are discrepancies between the country's regions. In 2021, informal employment levels were predominant in the north (58.6%) and northeast (55.9%) regions, while lower levels were verified in the southeast (33.9%) and south (26.8%) regions.

This informality constitutes an important source of inequalities, as these people have no access to social protection mechanisms, such as the right to retirement and paid maternity or sick leave.

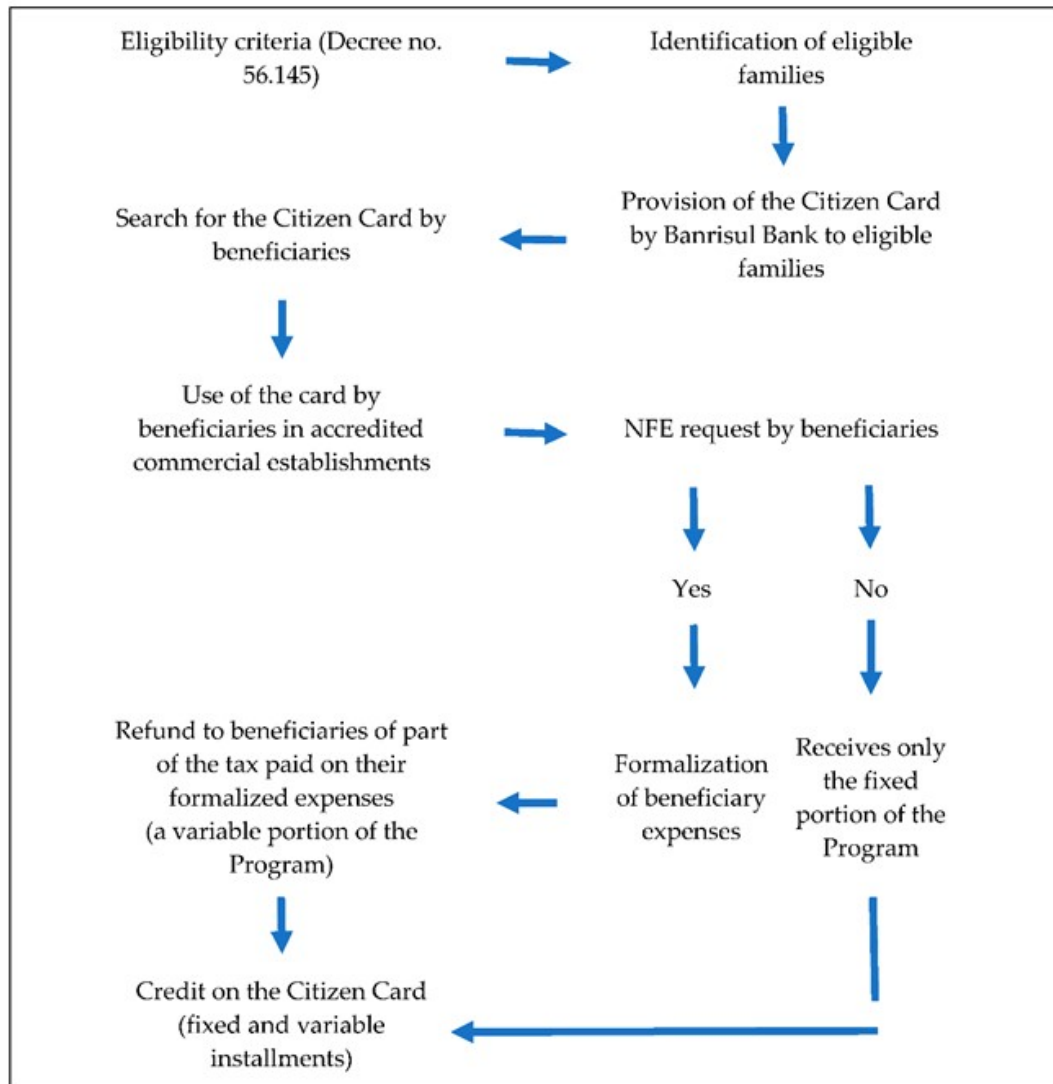
The implementation of social programs such as *Bolsa Família* managed to improve this situation for some time, but it has deteriorated in recent years. Dependence on benefits from social programs nearly doubled from 2012 to 2020. In this period, there was an increase in the

income vulnerability of the Brazilian population, with an increased proportion of people in the lower income brackets. Considering the per capita household income, the population in the 10% poorest bracket was the one that lost the most in this period (IBGE 2022).

Considering that, according to the World Bank, Brazil is an upper middle-income country, but with profound income inequality and high rates of poverty and labor informality, it is imperative to advance in the implementation of public policies that contemplate social inclusion and shared economic growth. However, given the high regional heterogeneity, it is possible that more focused programs—in terms of target populations and the regions where they live—be more effective than universal programs. The challenge of combating inequality often rules out miraculous solutions. As discussed by Banerjee and Duflo (2021), there is a need to understand where hope lies and why symbolic subsidies can have more than symbolic effects.

The *Devolve-ICMS* Program, the object of this study, is inserted in this context. It was implemented by the government of the state of *Rio Grande do Sul* in 2021 and consists of directly returning to the low-income population part of the amount corresponding to the tax levied on their purchases, based on the invoices issued in their Taxpayer Registration Number (CPF). It is, therefore, a tax customization that aims to mitigate tax regression and improve the living conditions of citizens, in addition to encouraging their engagement in a process of greater exercise of *fiscal* citizenship. The people targeted by this Program include those on the *Bolsa Família* Program register, as well as those selected according to other criteria (see Figure 5). There are similar experiences in other countries, mainly in Japan and Canada; however, to the best of our knowledge, this is the first tax personalization application to use the electronic invoice to quantify the consumption of beneficiary families.

Figure 5: Schematic illustration of the functioning and operationalization of the *Devolve-ICMS* Program



Source: Prepared by the authors.

This study aims to evaluate the impacts of the *Devolve-ICMS* Program on the consumption value of the beneficiaries and their participation in the tax issuance program. In addition, an estimate is made of the change in tax pressure by income bracket after the implementation of the Program.

To this end, the difference-in-differences method was applied. Program beneficiaries, in addition to meeting the eligibility criteria, need to pick up a card (Citizen Card), made available by Barrisul (the bank of the state of *Rio Grande do Sul*). Eligible people who did not pick up the card comprised the control group. The analyzed periods were the 12 months before and the 14 months after the implementation of the Program.

The results indicate that the Program has reduced the tax pressure on the low-income population. In addition, it increased the consumption of this segment of the population and

increased the number of invoices issued in their name. These results show that the Program is effective in improving the living conditions of the most vulnerable population in the state of *Rio Grande do Sul* and, consequently, reducing inequalities. This is the first impact assessment of the *Devolve-ICMS* Program using the difference-in-differences method.

In addition to this Introduction, this manuscript is composed of Section 2, which describes the *Devolve-ICMS* Program in detail. Section 3 presents a bibliographic review of the use of *fiscal* policies to face poverty and inequality, as well as other experiences in similar programs. Section 4 describes the methodology, presenting details on the database and the econometric models used. In Section 5, the results found are analyzed. Finally, Section 6 presents the main conclusions of this study.

3.2 THE *DEVOLVE-ICMS* PROGRAM

One of the characteristics associated with indirect taxes on consumption, such as the Tax on the Circulation of Goods and Services (ICMS), is their regressive nature; that is, the burden is proportionally greater on the income of relatively poorer families. Aiming to face this dysfunction, as of the 1980s, the technique of “differentiation” between tax burdens began to be widely used, with the objective of recording, in a more lenient way, the items with greater participation in the consumption structure of the poorest families. A classic example of this policy is the exemption of “basic food baskets”. However, this technique soon began to be questioned because of its ineffectiveness in mitigating regressivity. Given this, the government of the state of *Rio Grande do Sul* created the *Devolve-ICMS* Program, which presents a more effective logic to face the inequity of this tax, and favor income redistribution.

The tax administration office of the state of *Rio Grande do Sul* has evolved in the incorporation of innovations to its taxation and collection systems. The creation, 10 years ago, of the Electronic Invoice (NFE), which, having gone through several phases, today reaches the final consumer, is considered a milestone. Currently, 3 million people are registered in the *Rio Grande do Sul* invoice program, which represents more than 25% of the state’s population. An important stimulus to citizen participation is its system of prizes and monetary incentives. Every time a consumer requests the inclusion of their CPF in the tax document, points that are valid for monthly and instant raffles are generated. The expansion of the digital world through the Internet and data exchange has provided tax authorities with an enormous amount of information. New tools with immediate interaction have brought the tax authorities closer to the taxpayers and increased citizen participation, helping to combat tax evasion and unfair competition.

In this context, the *Devolve-ICMS* Program was implemented by the government of the state of *Rio Grande do Sul*, Brazil, in November 2021. It is an innovative program that has, as references, other similar programs and the doctoral thesis by da Silva (2017)—an employee of the State Revenue Office—that analyzed the personalization of the consumption tax. The personalization of this type of tax is still not widespread, but it has progressively gained visibility in recent years, both in the academic and political fields. In Brazil, this topic has been included on the agenda of the tax reform currently under discussion in the National Congress. In the Brazilian context, therefore, the *Devolve-ICMS* Program represents the first experience of tax customization.

The *Devolve-ICMS* Program consists of directly refunding the amounts corresponding to the tax levied on purchases formalized in NFEs to the low-income population. Thus, the Program directly returns to low-income people part of the amount corresponding to the tax incurred on their purchases, based on the invoices issued in their name (CPF). To the best of our knowledge, this is the first tax personalization application to use the NFE to quantify the consumption of beneficiary families and serve as a basis for tax refunds.

The target population of the *Devolve-ICMS* Program consists of families with income of up to three national minimum wages, or monthly per capita income smaller than half the national minimum wage. According to Decree no. 56.145 of 20 October 2021, these are the following requirements to participate in the Program: I—declared monthly per capita family income smaller than half the national minimum wage, or declared monthly family income of up to three national minimum wages; II—domiciled in the state of *Rio Grande do Sul*; III—head of household with an active Individual Taxpayer Registration Number (CPF); and IV—family unit that fits into at least one of the following hypotheses: (a) be a beneficiary of the *Bolsa Familia* Program, provided for in Federal Law no. 10.836 of 9 January 2004; (b) having a family member enrolled in regular secondary education in a state public school. Therefore, the Program aims to make state taxation more modern and fairer by reducing the tax burden on the neediest families.

Tax refunds occur through a bank card provided by *Banrisul* (the bank of the state of *Rio Grande do Sul*), called Citizen Card. This possibility of return was approved in 2020 by the *Rio Grande do Sul* House of Representatives through Law No. 15.576 of the Tax Reform. Cards are still being delivered, as there are still a significant number of beneficiaries who have not picked them up yet. In addition, updates to the *Cadastro Único*¹ require the printing and delivery of new cards. The card can be used in more than 140,000 establishments throughout the state, such as supermarkets, bakeries, pharmacies, and others, also strengthening the local

economy. Figure 1 illustrates the functioning and operationalization of the *Devolve-ICMS* Program.

The Program was designed to be implemented in stages. The first stage began in September 2021 and the second in July 2022. In the first stage, 432,000 families benefited, with a return of fixed installments of BRL 100.00 per quarter. In the second stage, the number of families covered increased to 527,000, and, in addition to the fixed portion, they began to receive a variable portion determined by the amount of expenses formalized in the NFEs.

The monetary incentives of the Program are shaping new taxpayer habits. To support behavior understanding, Fehr et al. (2015) present a behavior matrix (Behavior Change Matrix) based on empirical research that shows that contributions to the public good depend on two conditions: awareness of a social norm to contribute and willingness to contribute. To induce or educate people's behavior, several measures can be used, such as monetary incentives, educational measures, and "nudges". These measures can be very effective, but they depend on the specific contexts of the target population.

3.3 THEORETICAL AND EMPIRICAL REVIEW

Regarding the use of public policies based on consumption taxation, it is worth highlighting the solutions adopted in Japan and Canada, which are similar to the *Devolve-ICMS* Program implemented in *Rio Grande do Sul*. Despite the similarity regarding the tax refund to poorer people and families, it is important to highlight the profound differences between these countries regarding the importance of value-added tax (VAT). These two countries are among those that collect the least VAT as a percentage of their GDP and practice relatively low rates. Currently, Canada has a collection of 4.7% of the GDP, representing 13.6% of the amount collected, while Japan collects 4.9% of the GDP, corresponding to 14.9% of its collection (OECD 2022).

Japan has implemented a social inclusion program via VAT. For administrative convenience, the "customization" of the tax aims to produce exemptions in the consumption of specific products, corresponding to combinations between product and consumer, to eliminate the revenue losses typical of the general application of products to all consumers. This solution establishes variations in VAT, according to different combinations of products and consumers. This increases the complexity for companies to manage their tax obligations (Barreix et al. 2012).

Canada has opted for a simpler solution, which applies a uniform rate with exemptions for basic items, such as food and health-related products. To reinforce the tax reduction for the most vulnerable populations, it included a partial compensation mechanism for the tax passed on to the consumption of these groups. The amount of the transfer is defined based on marital status, number of family members, and taxpayer income level. It is simpler than the Japanese solution, as it is carried out in a single compensatory transfer operation, and not on each consumption operation (Barreix and Roca 2012). In Canada, the administration of benefits, which are in the form of credits, is the responsibility of the Canada Revenue Agency, which interacts in partnership with the federal, provincial, and territorial spheres. The credit is granted quarterly to low-income individuals and families to offset all, or part of, the tax paid on goods and services or harmonized sales tax. Eligibility is determined using information from the Personal Income Tax and Statement of Benefits.

Another alternative is the creation of a digital VAT (D-VAT) with the aim of combating regressivity, using technology to individualize consumption. This solution includes invoicing, declaration, and collection in real-time. There is a biometric identification of consumers, which allows the holder to be exempt from tax at the time of transaction, with minimal risk of fraud. Their purchases are taxed at a zero rate and do not accumulate VAT from previous phases. This proposal requires a massive investment in information systems, which would only be available to developed countries. The use of a D-VAT card may present problems in terms of user privacy (Barreix et al. 2012).

A great advantage of personalized VAT is that it tends to reduce tax regressivity, which ends up cooling the efficiency versus equity debate (da Silva 2017). However, the viability of a proposal will depend on the country's, or subnational's, poverty conditions, as well as on the funding sources and technical implementation conditions. There may be cases where the tax base is so eroded that a simple 1% increase in the rate will already allow the generation of resources to improve the situation of poverty and regression. However, if the poverty level is indeed very high, input from other fund sources may be necessary. Another possible source may be the inefficiently applied exemptions, whose reduction can generate enough resources to apply personalized VAT, gaining efficiency and equity.

When implementing public policies, one of the relevant errors refers to the issue of focusing. Barreix et al. (2012) point out that the inclusion error can extend benefits to groups that have the highest income in society, and this inclusion error configures a focusing error. The tax offset must consider the amount of the tax reduction or refund and the individuals who will benefit from it.

The objectives of the program must be conceptually defined: whether it will only seek to reimburse the tax paid in VAT or will seek adjustments in the distribution of the tax burden among taxpayers. A critical point is the base of beneficiaries that will be used. This base must have credibility, as the program will be managed on it. In this sense, Barreix et al. (2012) recommend using conditional cash transfer programs that are already in use. Latin America has had a successful experience with these programs for decades, and, in general, they respect traditional criteria for defining the socially vulnerable population. To define its beneficiaries, the *Devolve-ICMS* Program uses the same registration as the *Bolsa Familia* Program (PBF).

As for the individual amount to being refunded, several criteria can be applied. A first criterion is that it can be a fixed amount to be returned to the favored population. A second criterion would be regressive, which would consist in returning a percentage of the monthly purchases made electronically. This criterion favors the formal economy and improves tax equity and collection issues. This is considered a great virtue when there is a high level of informal employment. It needs significant investments in Information and Communication Technology (ICT). There is also the possibility of a hybrid model, with a fixed and variable portion. Tax refunds can be made on a monthly or quarterly basis by crediting to the target population's bank accounts or using an electronic debit card. The use of account credit presents a positive side, which is the possibility of being able to withdraw money in cash; however, it can confuse with other transfers and not contribute to the proposal of raising awareness of tax citizenship materialized in the use of a specific card for the program.

Some studies have addressed the efficiency of the option to exempt items from the basic food basket as a way of mitigating the effects of regressive taxation. In 2018 and 2019, the Federal Government published two bulletins on the subject (Ministry of Economy 2019; Ministry of Finance 2018). To get an idea of the dimension of the tax waiver, the relief on the basic food basket is one of the highest tax expenditures of the Federal Government, and, in 2018, it presented an estimated cost of BRL 15.9 billion, equivalent to 5.4% of the total tax expenditure. It has been justified by its impact on the disposable income of the poorest. Reports estimate that the 10% poorest spend about 23.3% of their income on products exempt from the basic food basket, while the richest spend around 2.8%. It should be noted that the basic food basket exemption policy does not distinguish tax benefits by income level or type of food purchased, despite prioritizing low-income people who are more vulnerable to food insecurity and nutrition (Ministry of Economy 2019).

The basic food basket exemption adopts as a premise the hypothesis that the exemption would be passed on completely to the final prices of the contemplated products, which would

allow cheaper products and increase access to the products in the basic food basket. However, it should be noted that this measure may not be effective in many situations, since the process of price formation in the economy depends on different market structures, the seasonality of agricultural production, and the price elasticity of food, among other factors. All this ends up influencing the focus. Some studies point to low elasticity for some products with a strong weight for the poorest, such as cereals, vegetables and tubers, pasta and bread, and chicken and eggs. In short, the exemption may not reach the intended final consumer (Ministry of Economy 2019).

The Ministry of Finance (2018) brought the historical context, economic fundamentals, *fiscal* dimension, international experiences, and a comparison of the results of this policy with income transfer programs. Based on a comparative analysis, the bulletin concludes that a direct income transfer focused only on the lowest-income population tends to be more efficient and effective for society than the basic food basket exemption policy, if the objective is to increase the welfare of the poorest.

The Ministry of Economy (2019) presented simulations of alternatives to the basic food basket exemption, comparing distributive effects. The tradeoff scenario highlights the total re-encumbrance of the basic food basket products and the total reallocation of its products to the PBF, and this demonstrated a more significant reduction in poverty and income inequality. An alternative proposal posed a scenario in which partial re-encumbrance of the basic food basket, with repercussions of 2.3% of the poorest 20% basket, and 11.2% of the richest 20% basket, would generate the amount of 1.2 billion, which, if applied to the PBF, would have the same effect in reducing poverty and income inequality. Even the scenario of egalitarian distribution of resources, without any focus, shows improvement in the indicators of poverty and inequality, which shows the regressive nature of the basic food basket exemption.

It is important to emphasize that, according to the Ministry of Economy (2019), in a scenario where the basic food basket exemption is only withdrawn without reallocating resources, there would be more people below the poverty line and an even greater effect on people below the extreme poverty line. It also points to a significant positive variation in the Gini index; that is, income inequality would also increase in this scenario. This is because the distribution of benefits from the basic food basket exemption, despite being regressive, is less concentrated than the distribution of the population's total income.

Araújo and Paes (2019) deepen the comparative analysis of the basic food basket versus the PBF, using a computable general equilibrium simulation. Their study used the neoclassical theoretical framework with discrete time, closed economy, and constant population and technology. In the model, there are two families differentiated by income level: one that

receives the PBF benefit and the other that does not, and the difference in income between these families is incorporated through the productivity parameter. The results showed that the increase in transfers generates a greater benefit to the well-being of the poorest class than the basic food basket exemption. The result persists for a targeting level of the PBF, as of 35.4%. For targeting levels lower than this, the basic food basket exemption is the best option. The 35.4% would be the balance point where the policies are equivalent. This emphasizes the importance of designing policies that maintain high targeting. Finally, it suggests the greater effectiveness of the PBF compared to the basic food basket exemption, regarding the objective of increasing the utility of the poorest.

3.4 MATERIALS AND METHODS

To analyze the effectiveness of *Devolve-ICMS*, we used a difference-in-differences (DID) model. This approach is one of the most used when the objective is to measure the impacts of social policies or programs (Angrist and Pischke 2014; Ryan et al. 2015). The main advantage of this method over the others is that it allows the control of the differences between the analyzed units, including over time. This increases confidence that the results achieved are specifically due to the analyzed program. However, for this to occur, it is crucial to observe parallel trends in the response variable between the treated and control groups before the program's implementation. This is the main difficulty in properly using this method. Figure 3 shows that, in this study, this condition is met, which justifies its use. The *t*-test did not reject the hypothesis of equality of the average values of the response variables between the groups before the Program's implementation.

For this, two groups were constructed: treated and control, both for two periods, before and after the launch of the Program. The treated group is formed by eligible families that received the benefit, and the control group is formed by families with similar characteristics to those of the treated group, but that did not receive the benefit; in this case, they had the right to the card and did not seek it. The groups are restricted to *Rio Grande do Sul*, where the Program exists. The variables used are in Table 5.

Table 5: Variables used in the model

Acronyms	Description	Minimum	Average	Maximum	Source
ref	Time in months (1, 2, 3, ..., 26)	1.00	1.36	26.00	Sefaz/RS
CPF	Identifier of person/consumer				Sefaz/RS
qtde_df	Monthly amount of Sefaz/RS tax documents	0.00	.06	109.00	Sefaz/RS
vlr_dfr	Monthly real values of invoices per person (updated by IPCA)	0.00	4.85	721.36	Sefaz/RS
TNT	<i>Dummy</i> (treated = 1; untreated = 0)	0.00	.48	1.00	Derivative
AD	<i>Dummy</i> (after = 1; before = 0)	0.00	.41	1.00	Derivative
comvarv	Monthly index of retail sales volume in RS	91.88	22.52	169.95	IBGE
pimit	Monthly index of production volume of the manufacturing industry in RS	95.44	09.27	120.13	IBGE

Source: Prepared by the authors.

The “ref” variable represents the months in which the data were consolidated, starting in November 2020, a year before the distribution of the Citizen Cards, and ending in December 2022, totaling 26 months. The “CPF” was used to identify the consumers. The variables “qtde_df” and “vlr_dfr” indicate the Program’s response (outcome variables), with the first indicating the monthly number of tax documents issued to the CPFs of people in the treatment and control groups, and the second indicating the monthly amount corrected for December 2022 using the IPCA.

To define the groups, the month of November 2021, when the cards were delivered, was used as a cut-off point between before and after the Program (AD). The “TNT” indicates the treatment and control groups. The treatment group consisted of people who had the card in November 2021, whereas the control group consisted of people eligible for the benefit and who did not seek their cards between November 2021 and December 2022. The last two variables, “comvarv” and “pimit”, were used as control variables. The first indicates the retail sales volume and the second the industrial production volume, both from the state of *Rio Grande do Sul*. These two variables were used as indexes.

An average of 300,000 beneficiaries were analyzed monthly. On average, 48.5% are in the treatment group and 51.5% in the control group. In all, 7,795,039 records of tax documents were used. Values from documents considered outliers were removed. Before this adjustment, the database contained 8,983,955 records. This broad database enabled the use of the DID model, which is the most widely used method to assess the impacts of social programs. This

method attributes to the intervention any difference in trends between the treatment and control groups that occur from the time the intervention begins. If other factors affect the difference in trends between the two groups, the estimate may be invalid or biased (Gertler et al. 2015).

The existence of a large group of eligible people who did not seek the card allowed the formation of a control group with characteristics similar to those of the treatment group (eligible people who sought the card). Without the card, the beneficiary does not receive the tax refund. The difference is that one group started benefiting from the Program and the other did not. This is important because it guarantees that the characteristics of the groups are similar, increasing the reliability of the model results. The use of control variables also supports the robustness of the results.

Possible reasons for eligible people not picking up the card: short time of Program implementation, and little information about the Program in the media. There is no reason to believe that this fact represents differences between the treated and control groups in such a way as to bias the results. In addition, both people in the control group and those in the treated group are part of the Single Registry—a register of people living in poverty and extreme poverty used by the Federal Government to implement social programs.

The validity of the underlying assumption of the equality of trends can be assessed, although it cannot be proved. A good test of the validity of this hypothesis is to compare changes in response variables for the treatment and control groups before the Program's implementation. If the outcome variables moved together for both groups, greater confidence is ensured that they would follow the same trend in the post-intervention period (Gertler et al. 2015). Figure 3 shows that the behavior of the two groups is similar before the Program. This increases confidence that the differences observed after the Program's implementation are due exclusively to its effect (Angrist and Pischke, 2009; Rosenbaum and Rubin, 1983).

The estimated model consisted of an unbalanced panel, because not all CPFs had records every month. Three panels were run: stacked, random effects, and fixed effects. In all cases, the Chow, Breusch-Pagan, and Hausman tests indicated that Fixed Effects modeling was the best, controlling for unobservable factors that are invariant over time. Furthermore, the models were estimated in a robust form to correct heteroscedasticity problems. In formal terms, the DD models used in this study can be written as follows:

$$\text{vlr_dfr} = \alpha + \beta_1 \times \text{AD} + \beta_2 \times \text{TNT} + \beta_3 \times \text{DID} + \beta_4 \times \text{comvarv} + \beta_5 \times \text{pimit} + \varepsilon \quad (1)$$

$$\text{qtde_df} = \alpha + \beta_1 \times \text{AD} + \beta_2 \times \text{TNT} + \beta_3 \times \text{DID} + \beta_4 \times \text{comvarv} + \beta_5 \times \text{pimit} + \varepsilon \quad (2)$$

Where: α , β_1 , β_2 , β_3 , β_4 , and β_5 are the estimated parameters, DID represents the AD^xTNT interaction, and ε is the error term. The other variables are defined in Table 6. Variable subscripts have been omitted. The parameter of interest in the model is β_3 , and the hypothesis is that it is positive and significant in both cases. For the first case, a positive β_3 means an increase in the monthly consumption of the treatment group concerning the control group. In the second case, a positive β_3 means an increase in the monthly number of tax documents.

Table 6: Summary of the amount returned by the Program by minimum wage ranges

Information	<1M.W.	1–2 M.W.	>2 M.W.	Total (Mean)
Number of beneficiaries	412,572	17,970	3,377	433,919
Families in the income range (%)	95.08%	4.14%	0.78%	100%
Average monthly income (R\$)	217.47	1634.24	2895.16	296.98
The average monthly amount returned (R\$)	35.93	71.72	85.93	37.81
Amount Returned/Income (%)	16.5%	4.4%	3.0%	12.7%

Source: Prepared by the authors based on data from SEFAZ/RS (Revenue Office of the state of *Rio Grande do Sul*).

3.5 RESULTS AND DISCUSSION

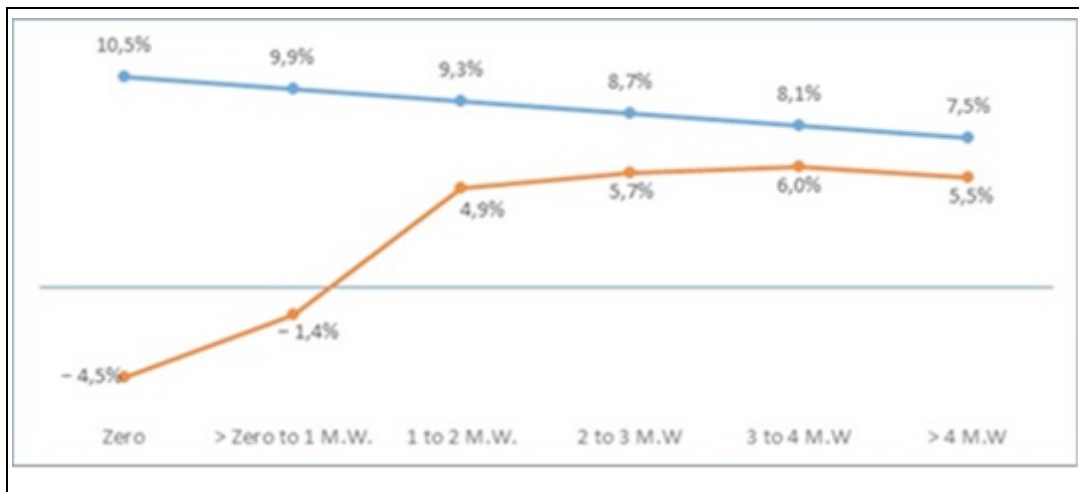
Tax refunds, as well as operational and costing expenses, are paid through the state's budget allocations, currently around BRL 200 million per year. As for the beneficiaries' profile, the data show that most of them are in the 31–40 age range (173,400 people), followed by the 21–30 age range (155,000 people). In terms of gender, the vast majority are women, accounting for 82.8% of all beneficiaries. As for the expenditure profile, the data indicate that 83% of the resources were used in the purchase of necessities in supermarkets, wholesales, butcheries, restaurants, and bakeries. Another 5.9% went to health products and services. Regarding the importance of the amounts returned, the data in Table 2 show that, for people with an income of up to one minimum wage (95% of the total), refunds represented more than 16% of their income.

Brazil has a complex *fiscal* and tax system with extremely relevant indirect taxation on consumption regarding collection. One of the effects of indirect taxation is *fiscal* anesthesia, which distorts the taxpayers from the perception of the tax they bear. Another important characteristic of consumption taxation is its regressivity, which consists of a greater tax burden

on those with lower incomes. Therefore, the decrease in tax regression contributes to improving the living conditions of the poorest citizens. With the database of this study, it was possible to determine the tax pressure profile (ICMS/Income) after the personalized returns of the *Devolve-ICMS* Program.

Figure 6 shows that the observed effects are fully in line with the expectations and objectives of the Program; that is, it has established *fiscal* progressivity in an originally regressive system. It can be noticed that the incidence, previously regressive (blue line), starts to behave in a markedly progressive way (orange line), especially in the range of up to two minimum wages, and slightly progressive (close to neutrality) from this range onwards.

Figure 6: *Fiscal* pressure by minimum wage brackets before and after the *Devolve-ICMS* Program



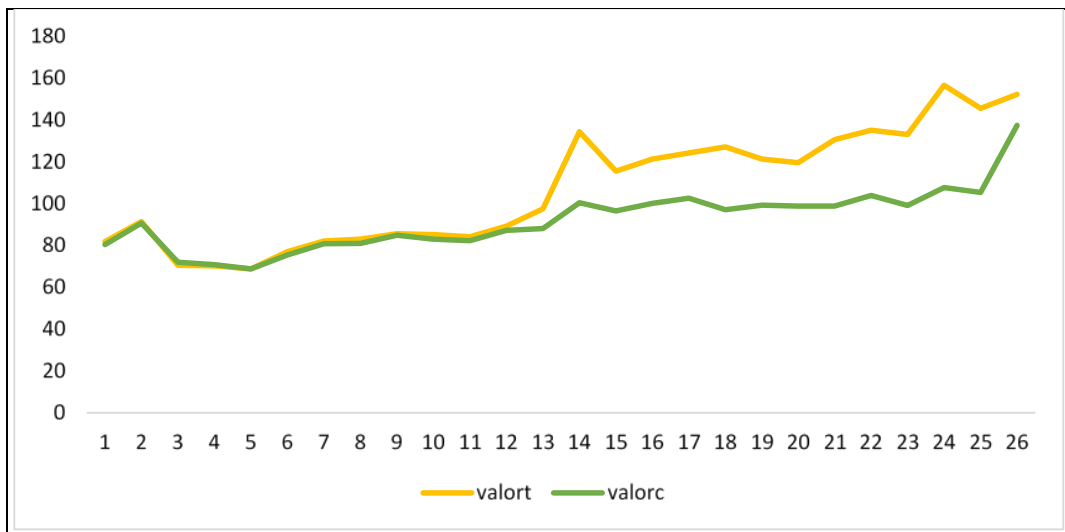
Source: SEFAZ/RS.

Note: The top blue line represents the time “before” the ICMS refunds; the bottom orange line corresponds to the time “after” the ICMS returns.

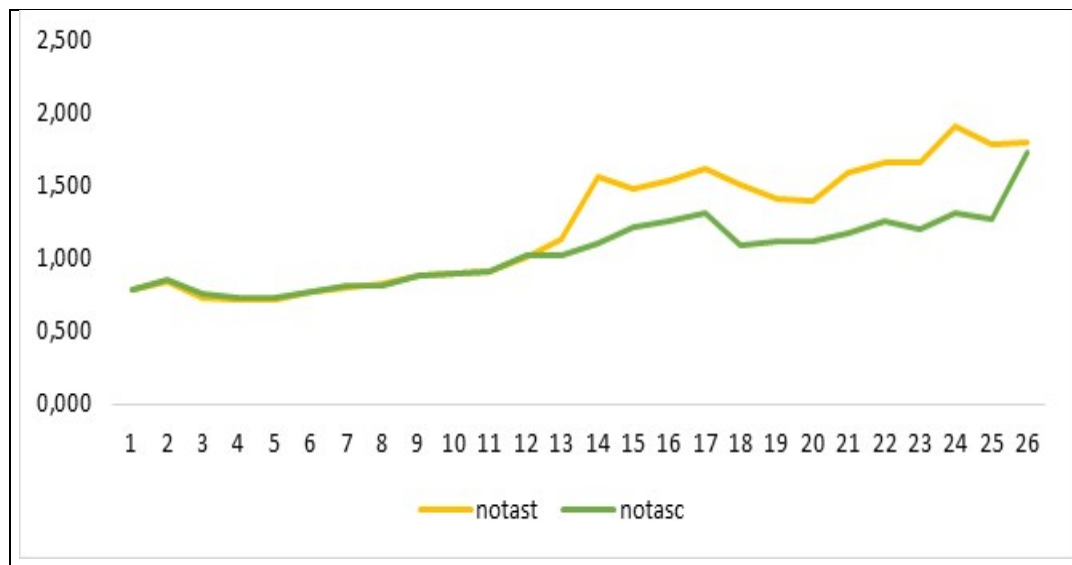
Figure 7a shows the similarity of behavior between groups regarding the value of tax documents before the start of the Program in November 2021 (month 13 on the horizontal axis). As of this month, the value varies between BRL 19.00 and 48.00 per month more in the treatment group. Figure 7b shows the behavior of the groups regarding the number of tax documents issued. Again, there is a great similarity in behavior before the Program and important differences after its implementation. From November 2022 (month 13), a higher monthly number of documents can be observed in the treatment group, ranging from 21 to 46%.

Figure 7: The behavior of the treatment and control groups before and after the implementation of the *Devolve-ICMS* Program

(a) Average monthly value of tax documents



(b) Average monthly number of tax documents



Source: Prepared by the authors.

Notes: valort = monthly value for the treatment group; valorc = monthly value for the control group; notast = monthly number of tax records issued by CPF in the treatment group; and notasc = monthly number of tax records issued by CPF in the control group.

Figure 7 provides evidence that the Program had positive impacts on the treatment group, in terms of the monthly amount and the monthly number of tax documents. The DID model enables statistical verification and quantification of these impacts. Regarding the impacts estimated using this method, Table 7 (1) shows the results for the monthly value of invoices. The model estimated that the treatment group had a monthly consumption of over BRL 32.47. This means that the *Devolve-ICMS* Program's resources have increased their living conditions,

since the resources were not used to pay debts or to any third parties, but resulted in an increase in their consumption. This was the expected result and matches the high focus of the Program.

Table 7: Results of regressions using fixed effects panel (robust)

	Value of Invoices (vlr_dfr) (1)	Quantities of Invoices (qtde_df) (2)
AD	18.8270 *** (0.2205)	0.3666 *** (0.0032)
DID (ATET)	32.4728 *** (0.3228)	0.4390 *** (0.0048)
comvarv	0.7220 *** (0.0047)	0.0050 *** (0.0000)
pimit	0.1496 *** (0.0087)	0.0028 *** (0.0001)
Observations	7,795,039	7,795,039
R-squared	0.0279	0.0435
F-statistic	52,840 ***	83,668 ***

Source: Prepared by the authors.

Notes: Standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The coefficient associated with the DID variable is the ATET (average treatment effect on the treated).

Regarding the number of documents issued with a CPF, verified in the invoice database, the model estimated that the treatment group had a monthly issuance of 0.43 documents (Table 7 (2)). This means that the Program encouraged the expansion of the beneficiaries' participation in the inclusion of their CPF in the invoice, indicating an improvement in *fiscal* education and, consequently, greater *fiscal* citizenship.

One of the pillars of tax education is the taxpayers' engagement in requesting companies to issue invoices. Invoice issuance ensures the registration of taxes collected from the consumer, and the government can control the payment of taxes by companies. Without this engagement, the government collects less, which may lead to restrictions on the supply of a series of public services, such as education, health, and security. With a low-tax education, everyone is penalized.

3.6 CONCLUSIONS

The first objective of this study was to evaluate whether the *Devolve-ICMS* Program managed to reduce the tax pressure on the low-income population. Using data from the consumption tax and income of the population, it was verified that the Program has reached this

objective. It relatively lessens the *fiscal* pressure on the population in lower income brackets, establishing progressivity in the tax incidence.

The second objective was to estimate the impacts of the Program on the value of consumption and the number of tax documents issued to beneficiaries. For this, the difference-in-differences (DID) method was used. To this end, two models were estimated, and the results showed that the beneficiaries had a monthly increase in consumption expenses and the number of invoices issued. These results suggest that the Program has improved the living conditions of the neediest population in the state of *Rio Grande do Sul*.

Other consequences of this Program were an increase in the formalization of economic transactions and an improvement in *fiscal* education. This greater engagement in requesting invoices increases government revenue, which may result in expansion and improvement in the provision of public services.

Other social programs seek to improve the economic conditions of the neediest citizens, such as the *Bolsa Família* Program and the basic food basket exemption. This study brings evidence of an innovative program on the national scene, the *Devolve-ICMS*, whose objectives are similar to those of previous programs, but with different characteristics. This is a focused program—applied at a subnational level—that consists in refunding the tax paid on consumption by the poorest people. The results obtained indicate that this Program has the potential to be expanded to other states of the Federation and, thus, be applied at the national level, as well as in other countries. The greatest virtue of the *Devolve-ICMS* Program is in its focus, resulting in efficiency gains in the use of public resources.

A limitation of the study is the relatively short period of analysis, since the Program was implemented approximately 12 months ago. Therefore, the trend is that, in the coming months, there will be an increase in the number of beneficiaries, greater engagement in requesting invoices, and higher consumption value. The idea is to continue evaluating the impacts of this Program, including new periods in the analysis, as well as other response variables, such as information on nutritional quality and inequality. In any case, the database used in this study is quite expressive, providing safety regarding the results.

Notes

- 1 The *Cadastro Único* is a set of data on Brazilian families living in poverty and extreme poverty.
- 2 To determine the initial *fiscal* pressure, that is, before refunds, it is necessary to estimate the tax borne by the beneficiary families by income range, which is obtained by applying the rates on consumption estimated in the Family Budget Survey (POF/IBGE). Therefore, to determine the *final fiscal* pressure, the individual amount of refunds is deducted from the initial pressure.

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4 MONETARY INCENTIVES IN TAX COMPLIANCE: A BRAZILIAN CASE STUDY

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Abstract. Motivation: To enhance tax education and increase citizen participation in combating tax evasion, one approach is the use of monetary incentives. In December (2021), the *Rio Grande do Sul* state government in Brazil launched the *Receita Certa* project. Targeted at the commerce sector, this initiative offers cashback rewards, refunding a portion of the consumption tax to citizens. The use of monetary incentives such as *Receita Certa* aims to model new taxpayer habits. **Purpose:** This article aims to analyze the impact of the *Receita Certa* project on consumer behavior, the real taxpayers, regarding the issuance of identified tax documents. **Methods:** This study evaluates the impacts of *Receita Certa* using a difference-in-differences model. The response variables are the monthly number and value of electronic invoices issued to beneficiaries. The treatment group consists of citizens eligible for the refund in its introduction month, while the remainder constitute the control group. The database includes invoices issued to 3.4 million taxpayers who added their tax identification on the invoice – spanning 11 months before and 18 months post-initiative, resulting in 46.7 million records. To claim the tax refund, citizens simply add their tax identification to the invoice and request redemption every three months. Refunds are contingent on certain conditions, such as revenue exceeding inflation. **Findings:** The results show that the *Receita Certa* is ineffective, as it decreased the number of tax documents issued and it is not significant about variable value of the documents. Additionally, the initiative's cost was high, highlighting the need for reevaluation and refinement. **Policy implications:** States that have a large tax gap need to improve their control systems. Initiatives like the *Receita Certa* that return resources widely to taxpayers to engaging them in evasion combat exist in many places. Public resources need to be allocated to projects that generate sound results.

4.1 INTRODUCTION

The state of *Rio Grande do Sul (RS)* has a long and rich tradition in Tax Education, firmly anchored in its official legal framework by Law 11,930, dated June 23, 2003. Today, the Tax Education program encompasses innumerable initiatives, including collaborative actions with schools, associative entities, municipalities, and the federal government.

An important step forward was the introduction of electronic invoices into the tax and business environment, marking a transition from a predominantly paper-based system to a digital one. With the aim of encouraging the issuance of invoices, RS has developed several

programs that offer rewards to citizens for including their tax identification during invoice generation.

These initiatives present a win-win scenario: they curtail opportunities for tax evasion, improving the efficiency of tax administration and strengthening state revenue. This, in turn, facilitates the provision of more services to the population. The digital environment enabled the launch of the *Menor Preço* Brazil application at the end of 2019. This tool proved invaluable during the COVID-19 pandemic by enabling citizens to find products at lower prices in close proximity, often avoiding the need for physical displacement and consequently mitigating the risk of contagion (Tonetto et al. 2023a). Another significant program was *Devolve-ICMS*, implemented at the end of 2021, with an important impact on the behavior of its beneficiaries. *Devolve-ICMS* sought to return a portion or all the tax levied on consumption to the lower-income population, aiming to eliminate or mitigate the regressive nature of consumption tax. The repercussions of *Devolve-ICMS* are explored in-depth in Tonetto et al. (2023).

Adding to these innovations is the unique *Receita Certa* project (*Rio Grande do Sul's* cashback system) – the primary object of this study. This initiative aims to refund part of the tax collected in the retail sector back to the citizen, contingent on its performance exceeding inflation rates. This article aims to analyze its impact on consumer behavior, referencing actual taxpayers. To this end, the difference-in-differences model was applied over 29 monthly periods, spanning 3.4 million contributors and 46.7 million observations. Tax education programs and projects play a very important role not only in curbing tax evasion but also in increasing awareness about indirect taxes, which often induce a phenomenon termed “tax anesthesia”.

Following this introduction, section II reports on the evolution of tax education in RS and describes in detail the *Receita Certa* project. Section III presents a literature review on behavioral economics, emphasizing the influence of monetary incentives both broadly and within the *fiscal* area. Section IV describes the methodology, detailing the database and econometric models used. In section V, the results found are analyzed. Finally, section VI presents the main conclusions of this study.

4.2 THE EVOLUTION OF THE TAX CITIZENSHIP PROGRAM IN RS

According to Souza and Souza (2018), the primary objective of tax education projects is to strengthen tax citizenship by spreading knowledge in society about the tax system and the

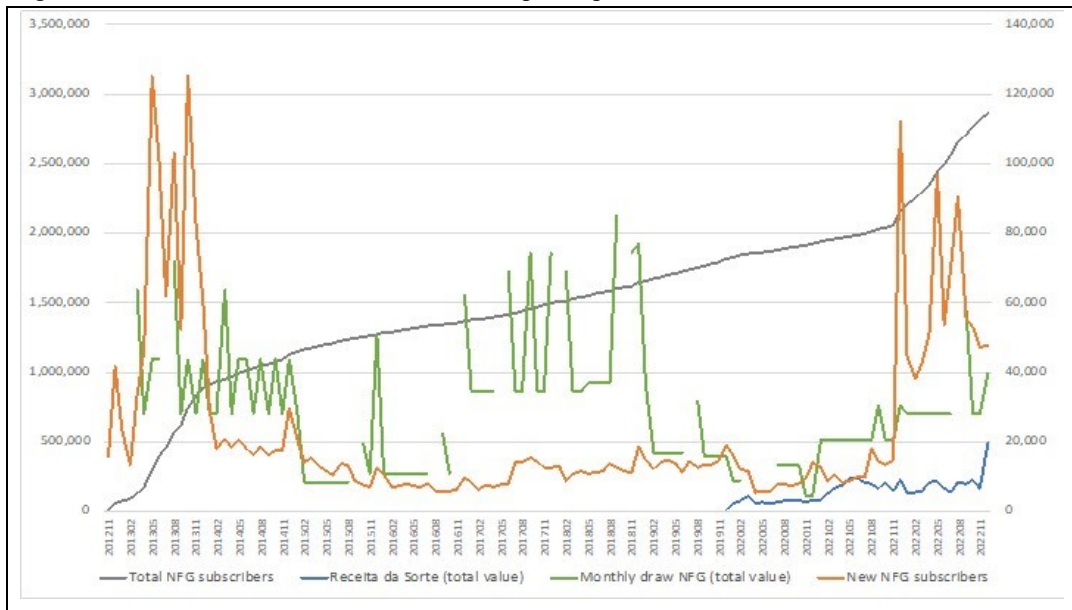
important role it plays in financing the Brazilian State. They aim for a cultural change by including the topic of tax education in the citizens' daily lives.

Fiscal citizenship programs in RS began in the 1980s with the *Bolão do ICM* program, which aimed to increase tax collection. There, the population exchanged invoices for coupons and competed in draws for various prizes. It was a way for the Revenue Office of RS (SEFAZ) to compare the amount of tax collected and declared by commercial establishments with the amount that actually circulated in the state, thus combating tax evasion. Today, in a very similar system but updated with the model of electronic invoices and monitoring via cell phone application, 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. These points are then converted into tickets that enable participation in monthly and even instant draws. At the end of 2022, 2,864,324 people were registered in the NFG Program. In 2023, the program had already reached 3 million participating CPFs, corresponding to almost 1/3 of the state's population. Figure 8 shows the evolution of rewards and citizen participation in the program. There was a rapid evolution of users at the beginning of the Program until reaching 1 million and, after this level, there was a gradual increase until the end of 2021, when it accelerated again. It can be seen that the growth trajectory of new participants in the NFG Program was not significantly changed with the launch of *Receita da Sorte*² in January 2020.

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

² *Receita da Sorte* is an instant prize that the taxpayer competes for if, when issuing the invoice, they submit it to the NFG application using a Qr code scanner. Around 50 prizes worth BRL 50.00 are available daily.

Figure 8: General data on NFG subscribers and prizes paid from Nov 2012 to Dec 2022

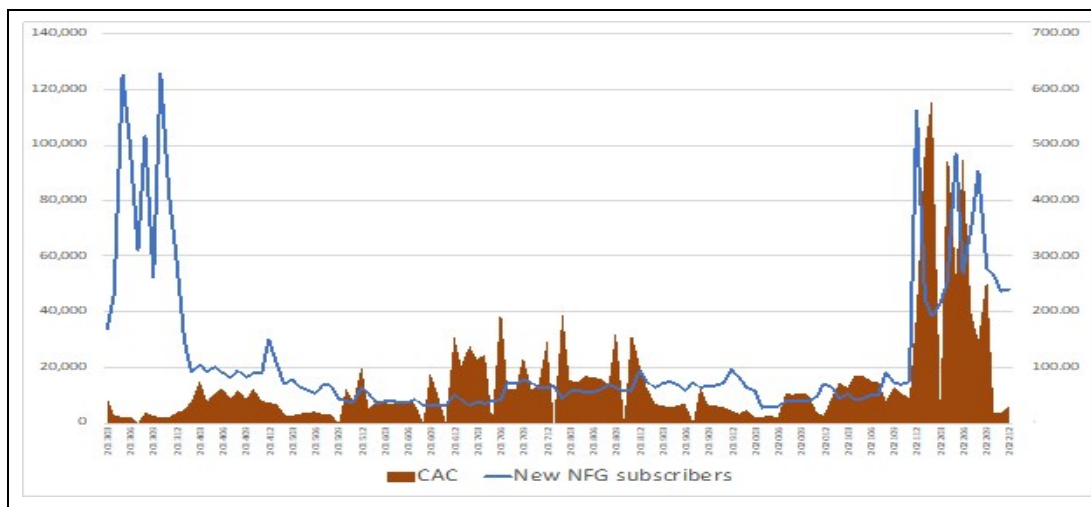


Source: SEFAZ/RS. Prepared by the authors.

Note: *Receita da Sorte* = Total amount paid by *Receita da Sorte*. A special draw from Dec 2014 was excluded.

It is also important to evaluate the cost of incentives through prizes and the variation of new citizens in the program. Figure 9 shows this over time. If we adapt customer acquisition cost concepts to this situation, we can see that the *Receita Certa* Project was effective in attracting new “customers” to the NFG program, though at a higher cost. The second payment, which was the largest for the period, amounting to BRL 73.9 million, is very close to the sum of all monthly prizes paid in nominal terms over almost a decade of the NFG program.

Figure 9: Cost of acquiring NFG participants (right axis) and new registrations (left axis)



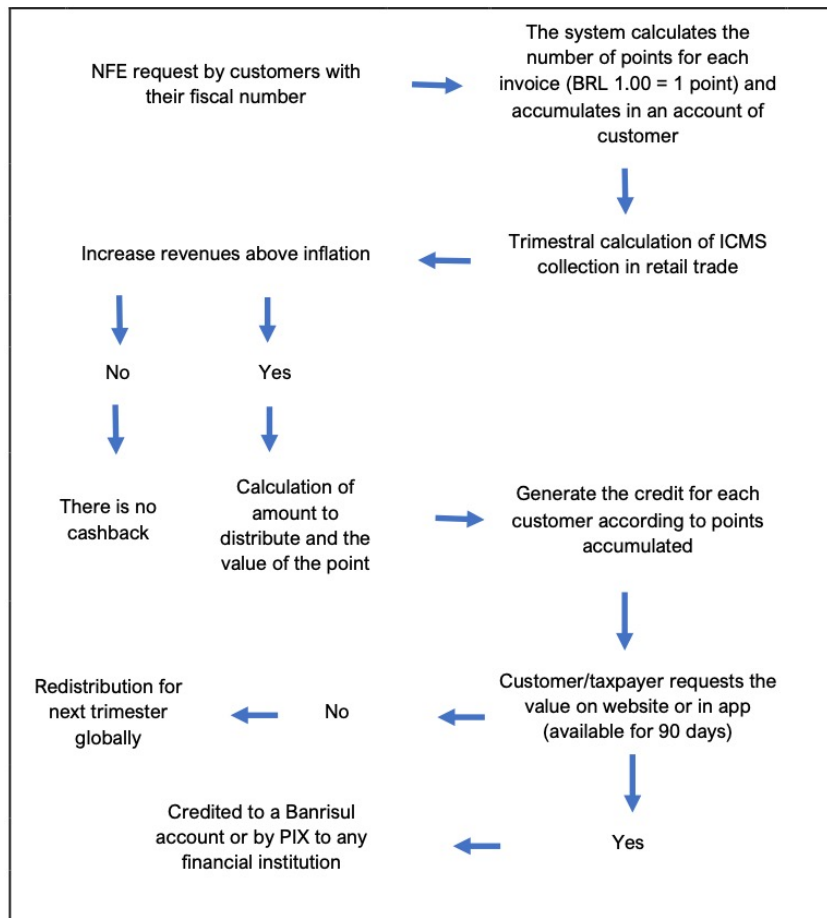
Source: SEFAZ/RS. Prepared by the authors.

Note: CAC = Cost of acquiring NFG participants. This cost is formed by the sum of all prizes, including *Receita Certa*, divided by the monthly variation in the number of subscribers to the NFG program. The *Receita Certa* payment was spread over three months, as it is a quarterly payment.

4.2.1 The *receita certa* project

Receita Certa distributes cash prizes to all citizens participating in the *Gaúcha Fiscal Invoice Program* (NFG). In this Program, there are points and prizes, but there is no draw. The reward occurs as long as there is a real increase in the *ICMS* (Tax on the Circulation of Goods and Services) collection from retail trade. The score serves to define the amount that will be distributed quarterly. The points valid in *Receita Certa* are those generated by purchases where the CPF has been added to the invoice, and the general rule is that for every BRL 1.00 1 point is generated. Some limits apply to the accumulation of points, such as a maximum of 1,000) points per tax document. In addition, the maximum monthly score per citizen is 5,000) points. The number of invoices per month in the same establishment is also limited to 30. Figure 10 shows the operationalization of the project.

Figure 10: Schematic illustration of the functioning and operationalization of the *Receita Certa* Project



Source: Prepared by the authors.

Notes: *Banrisul* = Bank of State of *Rio Grande do Sul*; PIX = Brazilian instant payment system, created by the Central Bank of Brazil; NFE = Electronic invoice.

The first distribution of values occurred only in December 2021 because of all the technology and budgetary and financial logistics required for its first cycle and, after that, there were four more distributions to taxpayers until May 2023. In one quarter, there was no distribution of values. It is important to highlight that the program only returns amounts to taxpayers if the collection conditions are met.

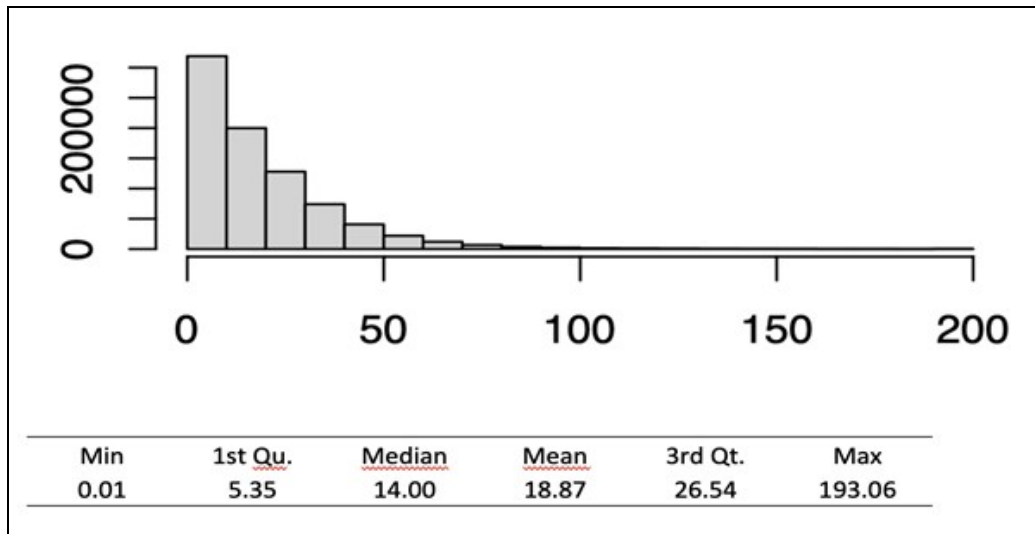
To receive the prizes, citizens simply access the NFG application or visit the NFG program website³. They can request redemption through PIX (CPF) or credit to their bank account. The deadline for receiving the redemption is 90 days after it is made available in the citizens' NFG program account. The project has not been able to strictly comply with the desired periodicity. The calculation regarding *Receita Certa* should be carried out every 3 months considering the previous quarter as a reference. Thus, the calculations would be in April for the January–March period, in July for the April–June period, and so on.

It is worth noting that the program did not distribute any amount for the first quarter of 2023 and it distributed BRL 73.9 million for the first quarter of 2022. This amount comprised the value referring to the quarter's increase (BRL 35,679,305.79) plus the value not distributed from uncashed prizes from the previous quarter (BRL 38,222,815.89). In order, the *Receita Certa* distributed in Dec 2021 BRL 64,6 million; in Apr 2022 BRL 73,9 million; in Jul 2022 BRL 39,5 million; in Nov 2022 BRL 18,2 million; in Feb 2023 BRL 7,2 million and the first period of 2023 Jan to Mar do not generate any cashback.

Uncollected prizes indicate misinformation about the program or a very low prize pool. The following distributions were based on amounts not collected and redistributed in the following quarter, considering that the targets were not achieved. Figure 11 presents the histogram of the variable values of the prizes distributed to the treatment group in December 2021, when the *Receita Certa* project was launched. In addition to the frequencies in relation to the prizes distributed, a description of the prizes in relation to their distribution is provided. It can be seen that there was no payment exceeding BRL 200.00, as well as that the first quartile was worth BRL 5.35.

³ Website of *NFG* <https://nfg.sefaz.rs.gov.br/site/index.aspx>.

Figure 11: Histogram and descriptive statistics of the variable distributed prizes

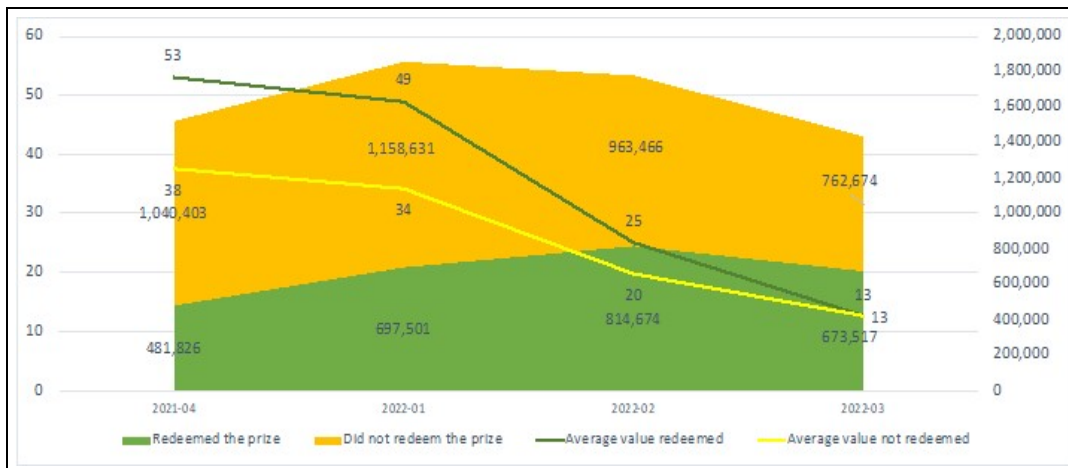


Source: SEFAZ/RS. Prepared by the authors.

Note: Values in BRL referring to the treatment group in December 2021, when the *Receita Certa* project was launched.

Figure 12 shows the number of taxpayers who cashed their returns and the number of those who did not, as well as the average values for each of these groups. A very large number of people who had credits to redeem did not do so. The average value declined for both groups in these four quarters evaluated.

Figure 12: Number of citizens who did or did not cash their *Receita Certa* values and respective average value in the first four quarters



Source: SEFAZ/RS. Prepared by the authors.

Note: No filter rule is applied to values.

4.3 BEHAVIORAL ECONOMICS AND MONETARY INCENTIVES

The behavioral economics approach provides valuable insights into the reluctance of taxpayers to exercise their tax citizenship. Faced with a complex tax system and distrust in the

effective allocation of resources by the State, several aspects can influence behavior, such as uncertainty, loss aversion, the presentation of services, and specific past experiences.

The use of monetary incentives such as *Receita Certa* aims to model new taxpayer habits and encourage those who have already started the process of change, thereby enhancing *fiscal* citizenship. Habits are not completely crystallized behaviors. Currently, we witness a series of habits undergoing transformation due to technological advancements or social norm shifts.

In support of understanding behavior, Fehr et al. (2015) present a matrix (*Behavioral Change Matrix*) based on empirical research that shows that contributions to the public good depend on two interconnected conditions: awareness of a social norm to contribute (*awareness*) and the consequences of not following this norm, and willingness to contribute (*willingness*). To induce or educate people's behavior, many measures can be used: monetary incentives, fines, legal punishments, educational measures, and nudges. These measures, and others, can be effective, but their effectiveness will depend on specific contexts, social norms, and individual characteristics of the target population.

According to Fehr et al. (2015), awareness, or knowledge, of the effects that one's behavior has on other people can have a major impact on one's decisions. However, empirical evidence indicates that people often have little or no knowledge of whether their behavior influences other people and society positively or negatively. For instance, when someone litters in a park, it might encourage others to do the same. Similarly, evading taxes or not asking for a receipt may discourage others from adhering to this behavior. In general, raising awareness alone is not enough to motivate behavioral change, as it occurs in the case of cigarette consumption, as many smokers continue to smoke in public. Disposition can support the process of behavioral change, and it is influenced by several factors, including social norms, perceptions of fairness, reward or economic costs, and individual behavioral preferences.

Economic incentives can affect willingness. People are aware of the problem but are not willing to change their behavior. Incentives, whether positive or negative, plus belief management, can be appropriate tools to resolve this situation. This is the classic case of applying amnesty to tax offenders.

4.3.1 Application in tax management

Highlighting monetary incentives and their use in behavioral economics, Bonner and Sprinkle (2002) review theories and evidence regarding the effects of monetary incentives on individual effort and task performance. They seek to understand these effects across various

accounting-related contexts. The authors develop a framework to seek understanding, because, according to them and based on the literature, monetary incentives have effects on effort and performance, which leads to the need to understand the factors that moderate their effectiveness.

The general consensus is that monetary incentives lead to greater effort than would otherwise occur. Some theories advocate that monetary incentives can lead to decrease in effort and performance. According to Deci and Ryan (1985), much research shows that monetary rewards decrease people's intrinsic motivation and also that observers infer less intrinsic motivation in people who are paid for an activity. For the authors, events such as choice and positive feedback have informative meaning and increase intrinsic motivation.

For Costa et al. (2022), tax evasion continues to be a relevant problem in Brazil and worldwide. They emphasize that behavioral economics has sought to understand behavior by carrying out experiments on individuals' decision-making processes. They analyze how decision-making can influence the effectiveness of behavioral interventions that seek to increase tax compliance. Their study was carried out through content analysis of scientific articles in the area. Emphasis is placed on contextual aspects and on how they influence intervention design. They report that the interventions have obtained results inferior to the predictions of initial studies in the literature. They conclude that the application of behavioral economics to achieve greater tax compliance can be effective, notably in cases where dishonesty does not arise from standard rational motivation.

In 2010, the UK government created an organization called Behavioral Insights Team (BIT), known as the Nudge Unit, whose role is to test new approaches to improve the efficiency and quality of public management. Today, the BIT has more than 200 employees and works to support several countries (Feitosa and Cruz, 2019; Meneguín and Ávila, 2019).

Feitosa and Cruz (2019) discuss the concepts behind the BIT and its potential for insertion into Brazilian tax law, with the design of possible new practices in the area of active debt collection. They emphasize that the most advanced Tax Administrations have evolved to analyze taxpayer conduct through the service paradigm, instead of pure enforcement. It is about creating a relationship of mutual collaboration between the Tax Authorities and the citizens. Many studies have addressed the technique of using nudges. Research carried out by the BIT revealed, for example, that changes in the way the text of a notification due to late tax collection is written can improve collection. These default reminders are generally of very low-cost and effective.

Concerning compliance with tax obligations, an experiment carried out by the government of the state of Minnesota, USA, showed that the dissemination of information that

90% of residents paid their taxes and were up-to-date with the tax authorities had an effect on the behavior of other taxpayers. When people receive information that compliance with the law is high, they become less likely to evade taxes (Sustein and Thaler, 2019).

Bird (2010), after analyzing international experiences using behavioral economics, states that there is not a one-size-fits-all formula that guarantees superior tax administration applicable universally. Countries exhibit a wide range of tax compliance levels. This variation reflects not only the effectiveness of their respective tax administrations but also the general taxpayers' attitudes toward both taxation and their government. These attitudes shape intentions, which in turn influence behavior. Such attitudes are formed within a societal context, influenced by factors such as perceived risk of evasion, perceived fairness and stability of the tax structure, its complexity, and the value attributed to government actions and their legitimacy. Government policies affecting any of these factors can influence taxpayer attitudes. Bird (2010) concludes that the ideal strategy would probably include rewards for those who comply and penalties for those who violate.

Many experiments based on behavioral applications have been carried out in different countries and states. The OECD (2017) highlights successful interventions. For example, New Zealand conducted a series of randomized controlled trials with its collection customer contact teams aiming to identify behavioral cues and apply them to improve interactions with individuals behind on their student loans and tax debtors. The test results revealed an overall 7-10% increase in debt recovery for teams that received the training compared with that did not.

Kachelmeier and Shehata (1992), in a study based in China, sought to identify individual risk preferences by observing choices in a series of dichotomous lotteries with varying probabilities of winning a monetary prize. What sets this study apart is that the subjects' decisions corresponded to real monetary rewards that were very large compared to their living costs. In the highest-pay condition, participants could earn up to three times their normal monthly income over the course of a two-hour experiment. The results indicated a statistically significant impact of the level of monetary incentives on revealed risk preferences. Even with extreme monetary incentives, individuals demanded amounts well above the expected value when faced with low-probability gain prospects.

Kahneman and Tversky (1979) present a critique of the utility theory as a descriptive model of decision-making under risk and, alternatively, present the prospect theory. For these authors, people underestimate merely probable results in relation to results obtained with certainty, generating a certainty effect that contributes to risk aversion in choices that involve certain gains and to the search for risk in choices that involve certain losses. Preferences can be

changed by different probability representations. They also highlight that excessively low odds can attract insurance and gambling.

A report by the World Bank (2014) highlights that a series of cognitive, psychological, and social barriers, in some cases difficult to observe, can interfere with productivity. These barriers can also shape the effectiveness of monetary incentives. For Read (2005), monetary incentives can affect behavior in several ways. They act on three factors: in cognitive effort, the incentive increases the amount of thought put into the task; in the motivational focus, the monetary incentive changes the agent's objectives; and the monetary incentive can also generate emotional triggers that cannot be predicted.

Fabbri (2015) introduced the term Lottery Ticket Reward Policy (LTRP) to describe interventions that employ lotteries to combat indirect tax evasion. Many countries have adopted this lottery mechanism to encourage taxpayers to exercise third-party control and impose the issuance of invoices. Upon analyzing the decision-making process, Fabbri (2015) highlights that the taxpayers demanding invoice issuance incur costs. These include potential losses from forgone price discounts and the moral cost from deviating from established behavioral norms. While these taxpayers bear these costs, the benefits of such actions are distributed across the entire population. Hence, in the absence of any governing policy, voluntary invoice requests would likely remain below optimal levels.

For Fabbri (2015), under reasonable values of the parameters that describe the risk and time preferences of the agents, for a sufficiently large lottery prize, the introduction of the lottery policy reduces tax evasion and increases net tax revenue. The outcome of policy implementation is positively correlated with the total amount of tax revenue collected and the size of the country's indirect tax gap. In short, the effectiveness of the LTRP depends on the specific socioeconomic situation in which the policy intends to be applied. A major problem with introducing incentives to enforce invoicing is that it might exclude voluntary enforcement. Empirical studies have shown that, in certain situations, offering a monetary reward can deter individuals who are intrinsically motivated from engaging in socially efficient behavior.

Marchese (2009) studied the effects of monetary incentives on tax evasion within competitive markets, elucidating their impact on government revenues. According to this author, a new type of receipt was introduced in China that functions both as a lottery ticket for larger rewards and a scratch card for small prizes, which aims to encourage customers to request official receipts as proof of payment in the service and retail sectors. Records of these printed receipts are automatically transmitted to the tax authorities, serving as a basis for calculating due taxes on sales. The initiative generates increased perception of risk of audits, with

consumers acting as auditors, albeit with the advantage of having more information about the product. However, Marchese (2009) warns that depending on market dynamics, this might lead to ‘market revenge’ through price increases. From an equity perspective, lottery incentives should result in more substantial value transfers to the economically disadvantaged recipients.

4.4 MATERIALS AND METHODS

To analyze the effectiveness of the *Receita Certa* Project, we used a difference-in-differences (DID) model. This approach is one of the most used when the objective is to measure the impacts of social policies or programs (Angrist and Pischke, 2014; Ryan et al. 2015; Bertrand et al. 2023). The main advantage of this method over the others is that it allows the control of the differences between the analyzed units, including over time. This increases confidence that the results achieved are specifically due to the analyzed program. The *t*-test did not reject the hypothesis of equality of the average values of the response variables between the groups before the program’s implementation. It is important to observe parallel trends in the response variable between the treated and control groups before the program’s implementation. This is the main difficulty in properly using this method.

For this study, two independent groups were constructed: treated and control, both for two periods, before and after the launching of the program. The treated group is formed by citizens that have the benefit distributed in December 2021, and the control group is composed of the citizens that added their CPF on the *fiscal* invoice in the in December 2021, but couldn’t receive the benefit of the project *Receita Certa*, because didn’t have any *fiscal* invoice in the previous three months. Table 8 shows the criteria.

Table 8: Empirical strategy for applying the DID model, T=29 and N=46,715,834

Groups	Criteria	Condition	Observations
Treated	Eligible to receive a refund in the first distribution of the project on December 2021	Should have issued at least 1 invoice with their CPF in the previous three months	14,281,021
Control	Citizen not eligible to receive the first refund on December 2021	Did not issued at least 1 invoice with their CPF in the previous three months	32,434,813
Period	Before	January 2021 until November 2021 (T=11 months)	18,060,580
	After	December 2021 until May 2023 (T=18 months)	28,655,254

Source: Prepared by the authors.

The groups are restricted to RS, where the Project exist. It should be noted that many citizens add their CPFs on the invoice for many reasons, such as warranties and others, but may not participate in the NFG program. The variables used in the model are presented in Table 9.

Table 9: Variables used in the model

Acronyms	Description	Minimum	Average	Maximum	Source
mes	Time in months (1, 2, 3, ..., 29)	1.00	14.77	29.00	SEFAZ/RS
CPF	Identifier of person/consumer			3,438,572	SEFAZ/RS
qtde_dfe	Monthly amount of Sefaz/RS tax documents	1.00	3.722	15.00	SEFAZ/RS
vlr_dfe_At	Monthly real values of invoices per person (deflated by IPCA)	0.8518	334.59	1000.00	SEFAZ/RS
TNT	Dummy (treated = 1; untreated = 0)	0.00	0.3057	1.00	Derivative
AD	Dummy (after = 1; before = 0)	0.00	0.6134	1.00	Derivative
ComVarS	Monthly index of retail sales volume in RS adjusted	85.52	97.38	107.16	IBGE
IPCA_ind	Inflation indicator as index	1.00	1.108	1.196	IBGE

Source: Prepared by the authors.

The variable “mes” represents the months in which the data were consolidated, starting in January 2021, eleven months before the first distribution of cashback by *Receita Certa*, and ending in May 2023, totaling 29 months. The “CPF” was used to identify the consumers. The variables “qtde_dfe” and “vlr_dfe_At” indicate the Program’s response (outcome variables), with the first indicating the monthly number of tax documents issued to the CPFs of people in the treatment and control groups, and the second indicating the monthly amount corrected for January 2021 using the IPCA.

To define the groups, the month of December 2021, when for first time the project has the monetary devolution calculated and distributed, was used as a cut-off point between before and after the Program (AD). “TNT” indicates the treatment and control groups. The treatment group consisted of people who received a value in December 2021, whereas the control group consisted of people who were not able to receive it on this occasion. The last two variables, “ComVarS” and “IPVA_ind”, were used as control variables. The first indicates the retail sales volume and the second represents inflation, the first from the state of RS and the second from Brazil. These two variables were used as indexes. Brazil faced a period of relatively high inflation rates (19.6% in that period), which may have caused a reduction in income and thus affected consumption.

A total of 3,438,572 CPFs were analyzed. It’s more than 31% of the population of the state of RS, that was 10.880.506 habitants in 2022. The treatment group has 812,792 CPFs, or citizens, whereas the control group has 2,625,780 CPFs. Important to say that this is an

unbalanced panel, which means that some citizens do not add their *fiscal* number every month, and that is the Project's focus, to stimulate the habit of including identification in *fiscal* invoices.

In all, 46,715,834 records of tax documents were used. We considered the following filters as the basis for our analysis: observations that have a value less than or equal to R\$1.00 and greater than R\$1,000.00 in nominal values, which is the limit for an invoice to participate in the project; and the number of documents greater than zero and a maximum of 15 (boxplot analysis).

Before this adjustment, the database contained 106 million records due to the way the data was extracted, because when there were no documents for a citizen in each month, a record with zero was added. This broad database enabled the use of the DID model, which is the most widely used method to assess the impacts of social programs. This method attributes to the intervention any difference in trends between the treatment and control groups that occur from the time the intervention begins. If other factors affect the difference in trends between the two groups, the estimate may be invalid or biased (Gertler et al. 2015).

The existence of a large group of people who were not able to receive the cashback contribute to the formation of a control group with characteristics similar to those of the treatment group (eligible people who did not add their CPFs on the invoices in the three previous months). If the beneficiaries did not add their CPFs on the invoices in the previous period, they are not eligible to receive the tax refund. The difference is that one group started benefiting from the Project while the other did not. The late commers are in control group. Citizens form both groups have added their identification to the invoices during the period of 29 months, but not all of them did it systematically. The initial month was a peak. In the period considered as after, the monthly average of number of citizens making up the treatment group was 482,653 and the control group was 1,109,305.

This is important because it guarantees that the characteristics of the groups are similar, increasing the reliability of the model results. The use of control variables also supports the robustness of the results. Possible reasons for eligible people not being able to receive the benefit include the short time of *Receita Certa* project implementation and little information about the project in the media. There is no reason to believe that this fact represents differences between the treated and control groups in such a way as to bias the results.

The validity of the underlying assumption of the equality of trends can be assessed, although it cannot be proved. A good test of the validity of this hypothesis is to compare changes in response variables for the treatment and control groups before the Project's implementation.

If the outcome variables moved together for both groups, greater confidence is ensured that they would follow the same trend in the post-intervention period (Gertler et al. 2015).

The estimated model consisted of an unbalanced panel, because not all CPFs had records every month. Two panels were run: pooled, random effects and fixed effects. In all cases, the Chow, Breusch-Pagan, and Hausman tests indicated that Fixed Effects modeling was the best, controlling for unobservable factors that are invariant over time. Furthermore, the models were estimated in a robust form to correct heteroscedasticity problems. In formal terms, the DID models used in this study can be written as follows:

$$vlr_dfe_At = \alpha + \beta_1 \times AD + \beta_2 \times TNT + \beta_3 \times DID + \beta_4 \times ComVarS + \beta_5 \times IPCA_ind + \varepsilon \quad (1)$$

$$qtde_dfe = \alpha + \beta_1 \times AD + \beta_2 \times TNT + \beta_3 \times DID + \beta_4 \times ComVarS + \beta_5 \times IPCA_ind + \varepsilon. \quad (2)$$

where: α , β_1 , β_2 , β_3 , β_4 , and β_5 are the estimated parameters, DID represents the AD \times TNT interaction, and ε is the error term. The other variables are defined in Table 3. Variable subscripts have been omitted. The parameter of interest in the model is β_3 , and the hypothesis is that it is positive and significant in both cases. For the first case, a positive β_3 means an increase in the monthly consumption of the treatment group compared with that of the control group. In the second case, a positive β_3 means an increase in the monthly number of tax documents.

A second analysis was carried out through group matching and checking changes in taxpayer behavior at three moments in relation to the moment before the project was implemented, represented by the sixth month before the first distribution. The database is the same one used in the previous analysis, with the same filters, but with the requirement that the taxpayer be enrolled in the NFG program and have invoices issued, including in the base month that corresponds to the sixth month prior to project implementation. This demonstrates that it is a group of contributors who are already familiar with the program. The analysis then focuses on months 6, 12, 19, and 26, with distribution of values from the *Receita Certa* project in the last three months beginning by month 12. The followable group (paired group) represented 195,621 people. In addition to checking whether its profile has changed, this also allows verification of the Project's costs and returns. To do this, the impact on the number of *fiscal* documents and their value is assessed, which translates into increased revenue in the group, and through the application of a modal rate and estimated tax gap, it can be compared with the value of the prizes distributed to this group, and this enables visualization of the cost-benefit.

Similar to the *Receita Certa* Project is the *Nota Fiscal Paulista* Program (NFP), as it offers a discount to consumers who request invoices and add their CPF on them, but it also has monthly

prizes in the form of draws and a reporting website. The NFP program was created by the São Paulo state government in October 2007 to reduce state VAT tax evasion and promote a culture of tax compliance. On average, the tax reduction is around one percent (1%) of the purchase value. The discount amount is 30% of the tax charged to the store that sold the item. On the other hand, the total value of monthly prizes is around 3%, one tenth of the value of the discounts that work as cashback (Naritomi, 2019).

Mattos et al. (2013) evaluated the NFP Program using the DID model and analyzed the data based on collection by sector in several states that have similar programs (AL, RJ, DF, CE, GO, PI, and BA) comparing the total and tertiary sector revenues in these states with the revenue of states that did not adopt tax incentive programs before and after the programs' implementations.

In a second analysis, they focused exclusively on the tertiary sector of the state of São Paulo. The analysis covered the period from January 2005 to April 2010, which represents approximately two years and ten months before and two years and five months after the program's implementation. The main objective of the program is to increase revenue in sectors that are difficult to monitor, such as retailers. It is also understood as a mechanism to encourage *fiscal* citizenship. It is aimed at changing taxpayer behavior through monetary stimulus. Both the government and the citizens can gain from this collaboration.

These authors observed a significantly positive effect of the program on real revenue in the tertiary sector, between 5 and 10% compared with other Brazilian states, but no robust effect was found on total real revenue. They also compared the increase in revenue in the tertiary sector with the prizes granted, and found an increase of up to 2% in the average revenue in the tertiary sector for São Paulo. They concluded that the impact of the program appeared to be limited. Reasons for that include the fact that a good part of the invoices come from establishments that already provide the invoice independently of the program, as well as that evasion could be lower than in other states. Another reason could be that many citizens have stopped asking for invoices because they fear data crossing or credit bureaucracy. These authors point out that an account credit system could be more effective, and warn that the study was quite aggregated, and that more disaggregated analyses may allow for better identification of the effect of the NFP program. They also justify the taxpayer's habit with behavioral economics, whether through factors such as fear of punishment, perception of the possibility of an audit, reward versus risk, transparency in public spending, and moral reasons.

A second study addressing the impact of the NFP program was carried out by Naritomi (2019) based on invoices with CPF addition covering the period from January 2009 to

December 2011, focusing on the prize system. It used the DID model and was based on the total number of identified invoices a consumer requests per month and the total monthly spending aggregated per consumer. The focus was on 24 draws conducted between July 2009 and June 2011. Lottery winners and a random sample of 10% of non-winners in each lottery draw were compared.

Naritomi (2019) points out that there is a significant difference in consumer participation in the program between lottery winners and non-winners, suggesting that lottery winnings can act as a nudge, increasing the chances of winning and reinforcing the propensity to ask for invoices. For Naritomi (2019), the relative effectiveness of lotteries compared with tax discounts would be relevant for a cost-benefit analysis, but the variation in the data did not allow distinction between the two in a convincing way. This author considers that evaluating the relative effectiveness of different reward systems is an interesting avenue for future research.

Naritomi (2019) also explores the impact of the launching of the NFP program on companies' reported revenues also employing a DID model. According to the study, there was a total increase in net revenue from rewards of 9.3%. In 2011, 50% of the rewards had not been collected. There were 27 million consumers who requested invoices but did not sign up online in the first four years of the program, which is the only way to claim rewards.

In 2022, the total value of credits from the NFP program was BRL 425.6 million, with a monthly average of credits of BRL 35.4 million directed to an average of 13.4 million beneficiaries. The average monthly benefit in 2022 was BRL 2.65³. There is reason to believe that the uncashed amounts remain high because of this low average value.

4.5 RESULTS AND DISCUSSION

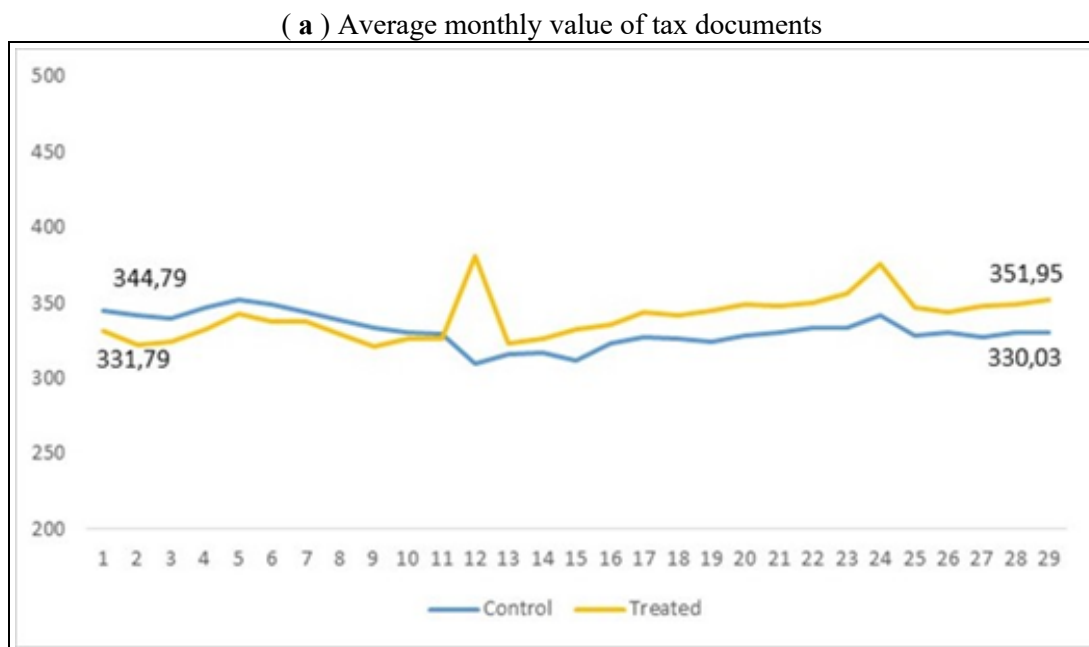
Brazil has a complex *fiscal* and tax system with extremely relevant indirect taxation on consumption. One of the effects of this indirect taxation is “*fiscal anesthesia*”, which distorts the taxpayers' awareness of the tax burden they bear. A cornerstone of tax education is encouraging taxpayers to actively request companies to issue invoices. Invoice issuance not only ensures the registration of taxes collected from the consumers but allows the government to monitor companies' tax payments. Without this engagement, the government collects less, which may lead to restrictions in the supply of a series of public services such as education, health, and security. With a low tax education, everyone is penalized. The panel model depicted in Figure 6 shows that the behaviors of the two groups analyzed are similar before the Project's

implementation. This similarity increases the confidence that any post-implementation differences observed are due exclusively to the Project's effect (Angrist and Pischke, 2009; Rosenbaum and Rubin, 1983).

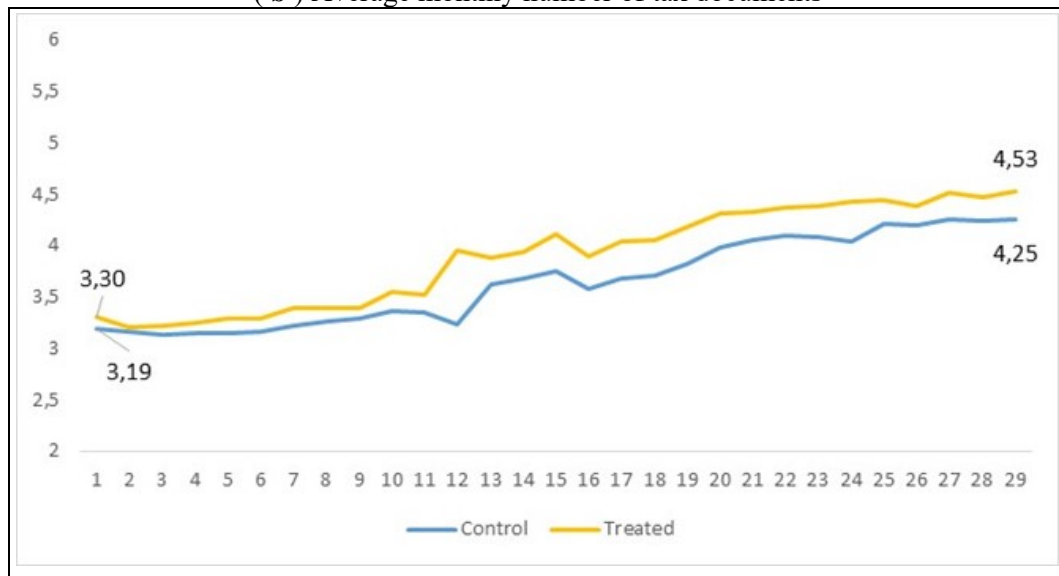
Figure 13 (a) shows the similarity of behaviors between groups regarding the value of tax documents before program's implementation in December 2021 (month 12 on the horizontal axis). Two peaks are noticed in months 12 and 24. The history of the record show a peak in December, when special rewards were distributed in the NFG program, as it can also be seen in Figure 8.

Figure 13 (a) shows that the line of the treated group starts quite similar to that of the control group, but slightly below, and then suddenly goes up and remains stabilized a little above. Figure 13 (b) shows the behavior of the groups regarding the number of tax documents issued. Again, there is a great similarity in behavior before the program's implementation and an important difference in the first month (22%, 0.7 documents), and after that some differences remain. From December 2021 (month 12), a higher monthly number of documents can be observed in the treatment group, ranging from 7 to 22%. The average above is 8% in the second period.

Figure 13: Behavior of the treatment and control groups before and after the implementation of the *Receita Certa* Project



(b) Average monthly number of tax documents



Source: Prepared by the authors

Notes: (a) Treated = monthly value for the treatment group; Control = monthly value for the control group. (b) Treated = monthly number of tax records issued by CPF in the treatment group; Control = monthly number of tax records issued by CPF in the control group.

Figure 13 (a) does not provide strong evidence that the program had positive impacts on the treatment group in terms of the monthly value of invoices. The parallelism continues without a clear slope. The DID model enables statistical verification and quantification of these impacts.

Regarding the impacts estimated using this method, Table 10 (1) shows the results for the monthly value of invoices. The model estimated that the variable DID is not significant. This means that the *Receita Certa* project's resources have no influence in the value of tax documents. This was the expected result in line with theoretical concerns about monetary incentives.

Table 10: Results of regressions using a fixed effects panel (robust)

Variables	Value of Invoices (vlr_dfe_At)	Number of Invoices (qtde_dfe)
	(1)	(2)
AD	4.8706*** (0.16922)	0.25253857 *** (0.00200478)
DID (ATET)	0.17342 (0.20143)	- 0.10124966 *** (0.00273995)
ComVarS	0.39176*** (0.0085095)	- 0.00977382 *** (0.00008828)
IPCA_ind	303.41*** (1.5112)	10.10669908 *** (0.01840782)
Observations	46,715,834	46,715,834
R- squared	0.0096874	0.07245
F- statistic	105.836 ***	845.084 ***

Source: Prepared by the authors.

Notes: Standard errors are in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The coefficient associated with the DID variable is the ATET (average treatment effect on the treated).

Regarding the number of documents issued with a CPF, verified in the invoice database, the model estimated that the treatment group had a monthly issuance of minus 0.1 documents (Table 10 (2)). This means that the project has an impact, but slightly negative, in the beneficiaries' participation in the inclusion of their CPF in the invoice, indicating that it is not improving *fiscal* education. The main variable in model 2 is inflation. Note that there is an increase of 19% in the price indicator in this period. The average numbers of documents issued in November 2021 were 3.35 and 3.51 for control and treatment groups, respectively, and in May 2023 they were 4.25 and 4.53, growth of 27% and 29%, respectively. The second model, Table 10 (2), shows that the project is not efficient.

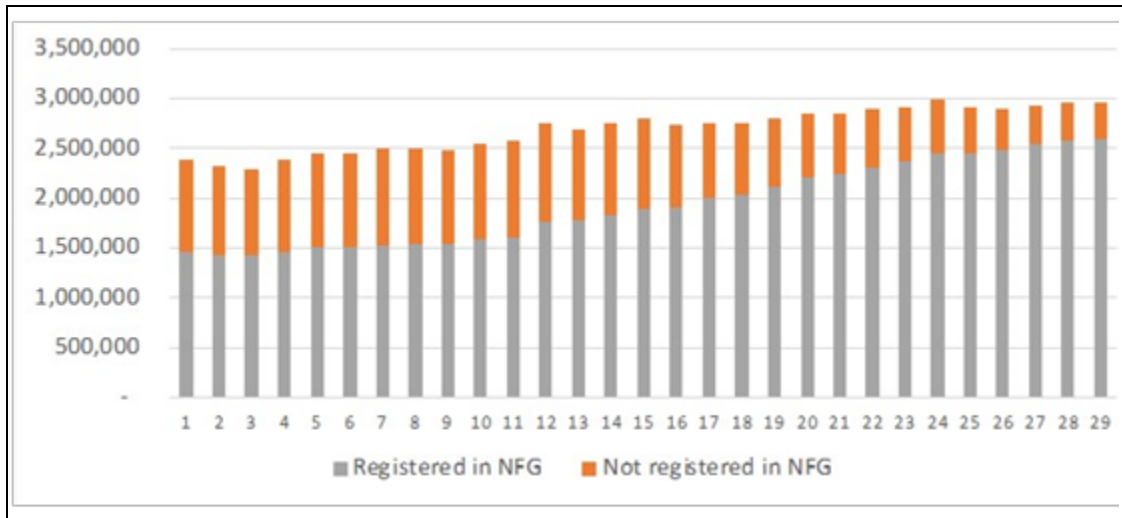
We can assume that these results are due to the design of the project that conditions the return on the performance of revenue from the retail sector. This includes uncertainty in the possibility of cashback. As it is quarterly, a rather long period, it accentuates this cashback uncertainty, which can contribute to disengagement.

The large number of low values that were not requested by taxpayers also seems to be a problem to be solved by a redesign of the program (Figure 12). And the attempt to reuse these remaining values to maintain some value to be distributed, did not seem to have any effect. And from a practical point of view, the regressive nature of the tax is even more aggravating because it should probably belong to people with lower incomes. The lack of massive publicity may also be a factor.

However, it appears that there was a migration of people who had already requested an invoice but were not registered in the NFG program, as shown in Figure 14. The substantial adoption of more taxpayers in the NFG global program is an undeniable merit of the program, as it allows for greater interaction with taxpayers through the APP. Previously, although taxpayers requested an invoice, they were not entitled to this greater interaction with the tax administration. They are therefore subject to the use of nudges in the form of smartphone notifications.

The average growth of new CPFs in the NFG Program in the 11 months prior to the project's implementation is 0.9%, while in the subsequent 18 months it was 0.8% – practically unchanged, which includes the large increase of 7% in the first month after the start of the *Receita Certa* Project.

Figure 14: Number of citizens, registered in all NFG programs and not registered, that included their tax identification number on invoices from January 2021 to May 2023



Source: Prepared by the authors.

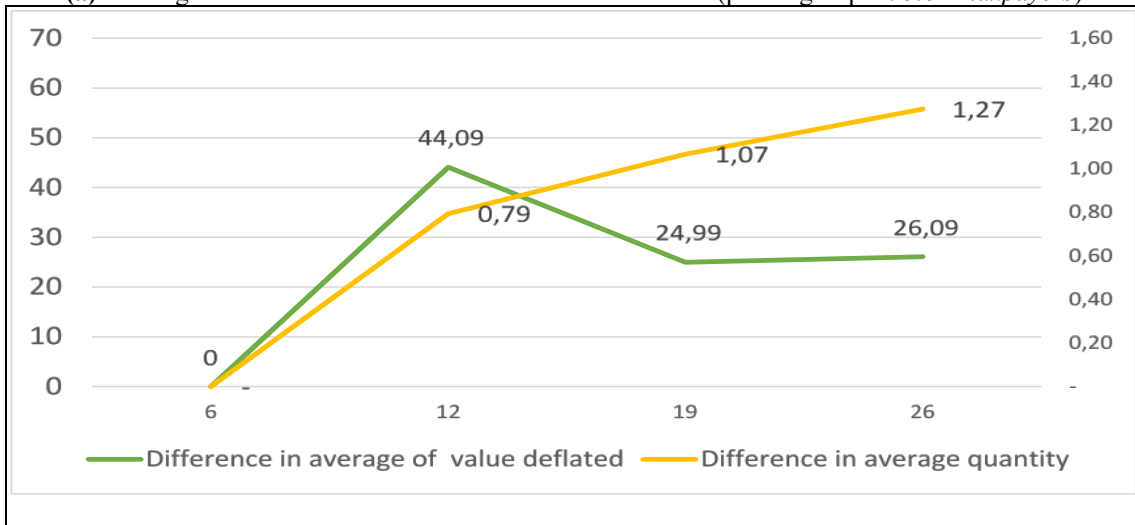
Notes: For this analysis, taxpayers who were issued more than 100 invoices per month were removed, as the average is around 5 documents.

Seeking to construct a cost-benefit analysis of the program to verify its effects considering economic incentives for taxpayers to request the invoice with their CPF, the program's entry month 12/2021 (month 12) was used as a base. By selecting the taxpayers who had the exclusive incentive from *Receita Certa* in that month and segmenting them, we sought to verify the behavior of the same 195,621 taxpayers at four important moments in the program: six months before (month 6), month of entry into the program (month 12), seven months after the first payment, time of the third payment (month 19), and the month of the last payment until may 2023, which had a much lower amount distributed compared with the others (month 26). These taxpayers show a certain regularity in requesting invoices as they all have documents issued in these four moments.

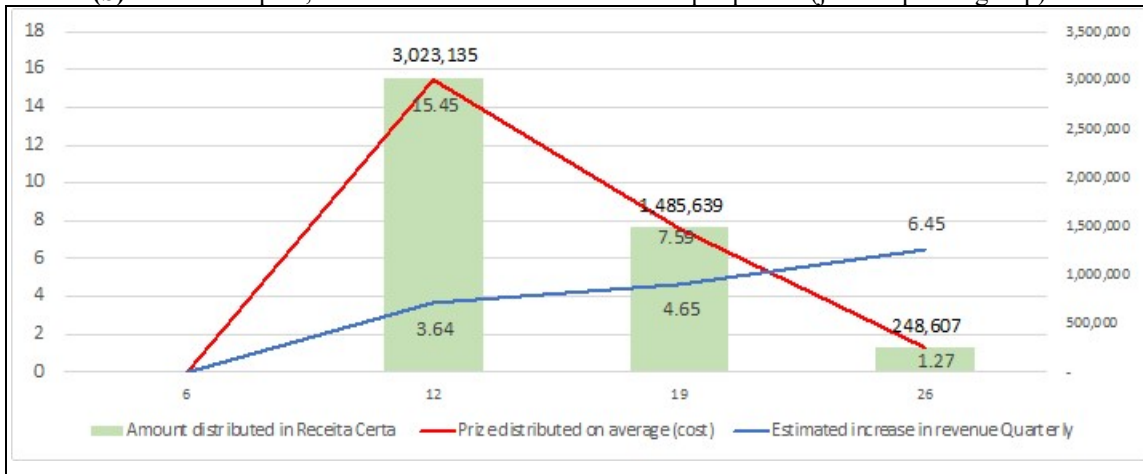
Figures 15 (a) and (b) represent the variation of subsequent periods in relation to month 6, always this as a reference, as the program did not yet exist. The increase in document issuance on average for the paired group at each time point in relation to month 6 and the same in relation to the value of tax documents issued were calculated. A revenue was estimated based on the increase in the number of documents and value for this group, considering quarterly effects and a reduction in the tax gap of around 11%, and then compared with the prizes paid to this group.

Figure 15: Increase in value and number documents for the paired group at four different moments

(a) Average increase in value and number of tax documents (paired group -195.621 taxpayers)



(b) Total value paid, increase in state revenues and cost per person (just for paired group)



Source: Prepared by the authors.

Notes: Figures 15 (a) and (b) show differences to the month six (6), before the project. In month 12, BRL 64.6 million were distributed by the *Receita Certa* Project, in month 19, BRL 39.5 were distributed, and in month 26, BRL 7.1 million were distributed.

These Figures 15 (a) and (b) show that for these engaged group the project has some influence, as the monthly value increased between BRL 25 and BRL 44 and there were additional 1.2 documents.

However, the amount spent on the first distribution was BRL 3 million, resulting in a cost per beneficiary of BRL 15.45 compared with an estimated benefit of only BRL 3.64. In month 26, when the cashback represented BRL 248,607, with an average cost of BRL 1.2, a benefit of BRL 6.4 was generated. This shows that, for this group, there may be a value that allows maintenance or increase in the growth of the number of documents and value, generating more benefits than costs.

4.6 CONCLUSIONS

The objective of this study was to evaluate whether the *Receita Certa* Project increased citizen participation to help tax compliance. Thus, we estimated the impacts of the Project on the value of consumption and the number of tax documents issued to beneficiaries. For this, the difference-in-differences (DID) method was used. To this end, two models were estimated, and the results showed that *Receita Certa* had no significance to increase the average value of the tax documents and there was a slightly negative impact on the number of invoices issued. These results suggest that the project has not succeeded as expected. The evaluation of *Nota Fiscal Paulista* (NFP) in 2013 had already shown concerns about the real impact of projects like this (Mattos et al. 2013). The NFP was also analyzed by Naritomi (2019), who found a positive influence of the lottery system on citizen behavior. The economic literature also tends to consider the relative effects of monetary incentives in behaviors (Deci and Ryan, 1985; Fabbri, 2015). This study strengthens this position.

The *Receita Certa* Project had an initial impact, which was not sustained. The project shows design problems. If we consider that the objectives of increasing revenues in commerce did not occurring in many quarters, and many taxpayers didn't redeem the cashback, probably because of be a small value and yet a lack of mass media information available. We can include the uncertainty of benefit as a great factor and the long period (quarterly), that accentuates the cashback uncertainty, which can contribute to disengagement.

There is evidence that people who used to add their tax identification on the invoices started to migrate to the NFG program, which is strongly positive for interaction with taxpayers, although this is not its main goal. The positive effect of the project is the substantial registration of more taxpayers in the NFG program.

One concern is that the value allocated to the program is not compatible with the results achieved. Paradoxically, the individual value can be mostly so small that it did not motivate many taxpayers to cash it. This huge number of rewards that were not collected was also pointed out by Naritomi (2019) in the *Nota Fiscal Paulista* program.

The data show evidence that the NFG program as a whole has improved citizen participation over the years. This greater engagement in requesting invoices has the potential to increase government revenue, reducing the tax gap, which may result in expansion and improvement in the provision of public services. Although the monthly average number of documents is not relevant yet, there is still a way to improve it.

This study brings evidence about the effectiveness of the *Receita Certa* Project. It can assist in designing more efficient policies using monetary incentives in tax education in Brazil and other countries, maybe combined with a nudge system. Distributing resources widely to many users does not seem to be the best solution, both in terms of cost and results. There is evidence that the distribution occurs to people with higher income, represented by a higher value redemption, and that smaller values are not cashed on a large scale. When uncashed resources are redistributed in a second moment, they end up worsening the phenomenon that occurs in the first moment. This is undesirable, as it is a regressive tax. It can be inferred that it increases tax regression in a perverse way.

A limitation of this study is the relatively short period of analysis, since the Project was implemented approximately 18 months ago. Therefore, the trend is the one presented.

We strongly recommend a continued evaluation of the impacts of this project, including new periods in the analysis, other response variables, as well as a combined assessment of the various NFG stimuli. In any case, the database used in this study is quite expressive, providing reliability to its the results.

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5 CONCLUSIONS

This thesis aimed to describe and analyze three innovative programs related to tax compliance and taxpayer behavior, that has held in State of *Rio Grande do Sul* from 2019 to 2022. All of them are based in the *fiscal* invoices. The results contribute to a better understanding of the taxpayer behavior and their engagement in each one of the programs.

The period comprise the turbulent COVID-19 time and the following months. We had a boost in digitalization worldwide, and in the governmental digital service was not different.

The first one innovation studied, the *Menor Preço* Brazil application, identified five structural breaks. These breaks were investigated by changes in the access to the application and fluctuations in the daily number of reported COVID-19 cases in Brazil. A regression model confirmed the impact of new COVID-19 cases on the usage of the search application. A 1% increase in COVID-19 cases led to a 0.2% increase in queries to the application. Furthermore, a 1% rise in the inflation index resulted in an 8.6% increase in the number of queries to the application. Also, the empirical analysis confirms the impact of COVID-19 in the use of technology. The use of the application *Menor Preço* Brazil increased due to issues related to the pandemic in the form of legal restrictions on circulation or even due to self-restriction caused by fear of contamination when leaving home. The theoretical approach in terms of behavior shows that when there was no perceived risk of loss, usage was high, spurred by the pandemic and inflation. However, when login requirements were introduced, concerns of loss aversion and increased tax scrutiny arose, as Congdon et al. (2011) announced, leading to a significant decline in usage. The study proves that the risk of aversion was important at that time, but fortunately it was possible to overcome it (Feitosa and Cruz 2019; Costa et al. 2022; Sunstein and Thaler 2019). Over time, the risk aversion was mitigated probably by strengthening trust in the government service, by understanding that its use did not present an excess risk of audit and invasion of one's privacy, and by the urgency of the COVID-19 situation, where the benefits of using the app—such as time savings, lower prices, and reduced risk of contagion—became more apparent.

The second study evaluate whether the *Devolve-ICMS* Program managed to reduce the tax pressure on the low-income population. Using data from the consumption tax and income of the population, it was verified that the Program has reached this objective. It relatively lessens the *fiscal* pressure on the population in lower income brackets, establishing progressivity in the tax incidence. Yet the impacts of the Program on the value of consumption and the number of tax documents issued to beneficiaries were estimated. The results showed

that the beneficiaries had a monthly increase in consumption expenses and the number of invoices issued. These results suggest that the Program has improved the living conditions of the neediest population in the state of *Rio Grande do Sul*. Other consequences were an increase in the formalization of economic transactions and an improvement in *fiscal* education. This greater engagement in requesting invoices increases government revenue, which may result in expansion and improvement in the provision of public services. The results obtained indicate that this Program has the potential to be expanded to other states of the Federation and, thus, be applied at the national level, as well as in other countries. The greatest virtue of the *Devolve-ICMS* Program is in its focus, resulting in efficiency gains in the use of public resources.

The objective of third study was to evaluate whether the *Receita Certa* Project increased citizen participation to help tax compliance. Thus, we estimated the impacts of the Project on the value of consumption and the number of tax documents issued to beneficiaries, as in *Devolve-ICMS* program.

The results showed that *Receita Certa* had no significance to increase the average value of the tax documents and there was a slightly negative impact on the number of invoices issued. These results suggest that the project has not succeeded as expected. The economic literature also tends to consider the relative effects of monetary incentives in behaviors (Deci and Ryan, 1985; Fabbri, 2015). This study strengthens this position.

The *Receita Certa* Project had an initial impact, which was not sustained. The project shows design problems. There is evidence that people who used to add their tax identification on the invoices started to migrate to the NFG program, which is strongly positive for interaction with taxpayers, although this is not its main goal. The positive effect of the project is the substantial registration of more taxpayers in the NFG program.

The data show evidence that the NFG programs analyzed in this thesis as a whole has improved citizen participation over the years. This greater engagement in requesting invoices has the potential to increase government revenue, reducing the tax gap, which may result in expansion and improvement in the provision of public services. The NFG program surpass 3 million users what represents almost one third of state habitants.

Although there always room for improvements.

Based in the perceptions gained with these studies, it could be recommended the following suggestions:

- a) Monitoring and storage the searches in App *Menor Preço* Brazil to help and guide public policies overall. This database is so rich in information.
- b) Expand the publicity of *Devolve-ICMS* and engaging social actors to reach the public target sooner and deeply.
- c) Monitoring the engagement of citizen in *Devolve-ICMS* especially about the variable refund.
- d) Monitoring and boot the partnership with municipalities.
- e) Redesign the *Receita Certa* Project.
- f) To eliminate the redirection of cashback that were not redeem, because it can worsen the regression of the tax.
- g) Estipulate a correlation between the number of documents historical issued by the taxpayer with the amount of the cashback.
- h) Monitoring de Cost of Acquisition of Client in all programs
- i) Estipulate a ceiling to cashback program or taxpayer, in order to compatibility between cost and benefits.

Limitations of this studies include the constraints of the available database, user or taxpayers' profiles, and other features at granular levels. Other limitation is the relatively short period of analysis.

Further studies can and should be carried out to understand more comprehensively citizen behavior concerning digital products and services. A new study project is underway that assesses the impact of using lotteries and instant prizes on taxpayer engagement in supporting tax compliance.

The idea is to continue evaluating the impacts of these programs, including new periods in the analysis, as well as other response variables, such as information on nutritional quality and inequality on *Devolve-ICMS* program. The *fiscal* invoice is full of valuable information that can guide the public administration in multiple purposes.

In any case, the database used in this study is quite expressive, providing safety regarding the results.



Pontifícia Universidade Católica do Rio Grande do Sul
Pró-Reitoria Acadêmica
Av. Ipiranga, 6681 - Prédio 1 - 3º andar
Porto Alegre - RS - Brasil
Fone: (51) 3320-3500 - Fax: (51) 3339-1564
E-mail: proacad@pucrs.br
Site: www.pucrs.br/proacad