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Benford's Law as an audit filter: an application to Pix amendments

Lei de Benford como filtro para auditoria: uma aplicação às emendas Pix

La Ley de Benford como filtro de auditoría: una aplicación a las enmiendas Pix

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Abstract:
Constitutional Amendment No. 105/2019 established the special transfer mechanism, known as the "Pix amendment," under which the Federal Government transfers funds directly to states, the Federal District, and municipalities without requiring an agreement or similar instrument, thereby reducing administrative steps. The large number of beneficiaries, amounts, and uses makes examination difficult and requires objective criteria for sample selection. In this context, Benford's Law can support screening by comparing the observed frequency of leading digits with the expected mathematical distribution, without significant differences constituting evidence of irregularities. The algorithm proposed by Cunha et al. (2016) was applied to 41,813 Pix amendment records from Siga Brasil for 2020–2025, totaling BRL 25.90 billion. First-digit, first-two-digit, and summation tests were used with the Z statistic, chi-square test, and Mean Absolute Deviation. The results showed a substantial deviation in the first-two-digit test. Combining observed frequencies with financial concentration selected 24 prefixes, comprising 35,424 records and approximately 77% of the amount examined. The greatest regional deviation occurred in the South, while investments showed the largest deviation by expenditure category. These groups provide an objective starting point for audit planning without implying irregularity. Sample selection should also consider materiality, the history of the beneficiary and funded purpose, implementation stage, information quality, complaints, and professional judgment. Benford's Law serves as a screening tool and does not replace documentary analysis or the collection of audit evidence.

Keywords:
Benford's Law. Pix amendments. Government auditing. Special transfers. Audit sampling.

Resumo:
A Emenda Constitucional nº 105/2019 criou a transferência especial, conhecida como "emenda Pix", modalidade em que a União repassa recursos a estados, ao Distrito Federal e aos municípios, sem convênio ou instrumento semelhante, reduzindo etapas administrativas. A grande quantidade de beneficiários, valores e aplicações dificulta o exame de todas operações, exigindo critérios objetivos para a seleção de amostras. Nesse contexto, a Lei de Benford pode auxiliar na triagem ao comparar a frequência observada dos primeiros dígitos com a distribuição matemática esperada. Como metodologia, aplicou-se o algoritmo proposto por Cunha et al. (2016) a 41.813 registros de emendas Pix do Siga Brasil, referentes a 2020–2025 e correspondentes a R$ 25,90 bilhões. Foram utilizados os testes do primeiro dígito, dos dois primeiros dígitos e da soma, associados à estatística Z, ao qui-quadrado e à Média dos Desvios Absolutos. Os resultados indicaram afastamento relevante no teste dos dois primeiros dígitos. O cruzamento entre frequências observadas e concentração financeira selecionou 24 prefixos, reunindo 35.424 registros e cerca de 77% do valor examinado. Entre as regiões, as emendas destinadas ao Sul devem ser priorizadas por apresentarem o maior desvio do padrão matemático. Assim, os resultados oferecem ponto de partida objetivo para o planejamento da auditoria, sem constituir juízo prévio de irregularidade. Adicionalmente, a definição da amostra deve considerar materialidade, histórico do beneficiário e do objeto, fase de execução,

qualidade das informações, denúncias e julgamento profissional. A Lei de Benford funciona como instrumento de triagem, sem substituir a análise documental e a formação de evidências.

Palavras-chave:
Lei de Benford. Emendas Pix. Auditoria governamental. Transferências especiais. Seleção de amostra.

Resumen:
La Enmienda Constitucional n.º 105/2019 creó la transferencia especial, conocida como "enmienda Pix", modalidad mediante la cual el Gobierno Federal transfiere recursos directamente a los estados, al Distrito Federal y a los municipios, sin convenio ni instrumento similar, reduciendo así las etapas administrativas. La gran cantidad de beneficiarios, importes y aplicaciones dificulta el examen de todas las operaciones y exige criterios objetivos para seleccionar muestras. En este contexto, la Ley de Benford puede contribuir a la selección al comparar la frecuencia observada de los primeros dígitos con la distribución matemática esperada. Como metodología, se aplicó el algoritmo propuesto por Cunha et al. (2016) a 41.813 registros de enmiendas Pix de Siga Brasil, correspondientes al período 2020–2025 y a R$ 25,90 mil millones. Se utilizaron las pruebas del primer dígito, de los dos primeros dígitos y de la suma, asociadas al estadístico Z, al chi-cuadrado y a la Media de las Desviaciones Absolutas. Los resultados indicaron una desviación relevante en la prueba de los dos primeros dígitos. El cruce entre las frecuencias observadas y la concentración financiera seleccionó 24 prefijos, que reúnen 35.424 registros y cerca del 77 % del importe examinado. Entre las regiones, deben priorizarse las enmiendas destinadas al Sur, por presentar la mayor desviación respecto del patrón matemático. Así, los resultados ofrecen un punto de partida objetivo para la planificación de la auditoría, sin constituir un juicio previo de irregularidad. Además, la definición de la muestra debe considerar la materialidad, los antecedentes del beneficiario y del objeto financiado, la etapa de ejecución, la calidad de la información, las denuncias y el juicio profesional. La Ley de Benford funciona como instrumento de selección y no sustituye el análisis documental ni la obtención de evidencia de auditoría.

Palabras clave:
Ley de Benford. Enmiendas Pix. Auditoría gubernamental. Transferencias especiales. Selección de muestras.

1 Introduction

The digitization of public organizations has expanded the use of systems capable of collecting and analyzing large volumes of data, favoring the consolidation of remote and data-driven audits. The increase in the volume of transactions to be analyzed in shorter periods made its manual verification unfeasible and stimulated the development of data collection systems and computational audit tools (AQUINO et al., 2022).

Special transfers of individual amendments help to understand this problem. Established by Constitutional Amendment No. 105/2019, they allow the Federal Government to transfer resources directly to states, the Federal District and municipalities, without a similar agreement or instrument. The speed of this mechanism popularized the expression "Pix amendment." At

the same time, the decentralization of execution made relevant the ability to connect the parliamentary nomination, the beneficiary, the funded object, the bank account and the results delivered (BRAZIL, 2019; BARBOSA, 2025).

Complementary Law No. 210/2024 reinforced the need for improvements in providing for the identification of the object and value, the indication of specific account, the presentation of work plan and the publicity of the execution. Recent oversight of the Court of Auditors of the Federal Government also recorded failures of planning, traceability and control in part of the transfers examined. This does not mean assuming irregularity in each transfer, but evidences the need for filters capable of ordering the control effort (BRAZIL, 2024; UNION COURT OF AUDITORS, 2025).

In this context, an alternative to screening is Benford's Law, according to which the first digits of many numerical sets are not distributed uniformly. Digit 1 tends to appear at the beginning of the values more frequently than 9, and regularity can be extended to pairs of 10 to 99. When the observed distribution departs from the pattern, the result signals numerical ranges that deserve explanation. The discrepancy between the observed situation and the pattern, however, does not reveal its cause. It may be related to roundings, administrative limits, program characteristics, duplications and registry errors can also produce deviations (DURTSCHI; HILLISON; PACINI, 2004; CLEARY; THIBODEAU, 2005; NIGRINI, 2012).

In the field of public works, Cunha, Bugarin and Portugal (2016) developed a procedure that employs Benford's Law in the selection of samples for audit. The method combines the deviations observed in the frequency of the first two digits with the financial relevance of each prefix, in order to concentrate the analysis in records that represent between 75% and 85% of the total value examined. Its main contribution is not in classifying a population as regular or irregular, but in transforming statistical deviations into objective and reproducible criteria for prioritization. of the usefulness of this approach, there are still few researches on special transfers, and in particular, studies that apply mathematical methods to the definition of samples of Pix amendments for auditing.

In the face of this gap, the research question that guides this study is: how do the settled amounts of the Pix amendments between 2020 and 2025 behave in relation to Benford's Law and which strata should be prioritized when applying the method of Cunha, Bugarin and Portugal (2016)?

In order to clarify this issue, the main objective of this article is to analyze the behavior of the settled amounts of the Pix amendments in the period from 2020 to 2025 in relation to

Benford's Law and identify, through the application of the method of Cunha, Bugarin and Portugal (2016), the priority strata for the selection of audit samples.

The contribution of the study is to apply to special transfers an objective and reproducible procedure of sample selection, which combines the deviations in the distribution of the first two digits with the financial relevance of the records, allowing to prioritize strata for audit without treating the statistical alert as proof of irregularity.

In addition to this introduction, the article is divided into four sections. The theoretical framework examines special transfers, traceability and control problems, and the use of Benford's Law in the selection of records for audit. The methodology presents the database, statistical tests and sampling algorithm. Afterwards, the results gather the general diagnosis and the cutouts by region and group of nature of the expenditure, with attention to the consequences for the planning of the inspection. Finally, the final considerations are presented.

2 Theoretical framework

2.1 Special transfers, traceability, and control

The parliamentary amendments constitute a mechanism for the participation of the Legislative Branch in the allocation of the public budget. The institutionalization of the mandatory amendments expanded this participation and reduced the discretion of the Executive Branch on its execution, once the applicable technical requirements (VIANA; PECI, 2026) were met. In this context, Constitutional Amendment No. 105/2019 created the special transfer as a modality of the individual imposing amendments. The resources are passed directly to the federated entity, regardless of agreement or similar instrument, and become part of the beneficiary at the time of the financial transfer. Its application must occur in finalistic programs of competence of the local Executive Branch, being prohibited the use in personnel expenses and in the service of the debt. In addition, at least 70% of the proceeds should be allocated to capital expenditures (BRAZIL, 2019).

The dispensation of covenant and other similar instruments makes the transfer faster, although the special transfer presents less procedural control than the modality with defined purpose. Its monitoring depends on consultation with different public systems. Follow Brazil gathers budgetary and financial information, such as authorized, committed and paid amounts, while the Parliamentary Panel and Transferegov present data on action plans, execution

situation and management reports. Thus, the information related to the transfer of the Federal Government does not allow, in isolation, to know how the resources were used by the federated entity after receipt. To increase transparency and oversight, management reports should gather documents related to administrative procedures, contracts concluded, invoices and bank statements (BARBOSA, 2025).

Complementary Law No. 210/2024 established new requirements for the execution of special transfers. The author of the amendment must inform the object and the value of the transfer at the time of the indication of the beneficiary, who, in turn, must indicate a specific checking account in Transferegov.br. The Executive Branch of the benefited entity must also communicate, within 30 days, the amount received, the work plan and the execution schedule to the respective Legislative Branch, the Court of Auditors of the Federal Government and the courts of state or municipal accounts, giving wide publicity to this information. the standard also provides that the transferred resources are subject to the assessment of the Court of Auditors of the Federal Government (BRAZIL, 2024).

The recent literature points out that the institutionalization of mandatory amendments favored the dispersion of resources in numerous individual decisions and enhanced localism and particularism in budget allocation. This profile can compromise the efficiency of governance and management of public resources, especially when decisions meet local or sectoral demands at the expense of broader and collectively defined priorities (VIANA; PECI, 2026).

In the municipal financing of the Unified Health System, transfers from parliamentary amendments have greater instability and per capita variation than regular federal transfers. The values received can vary significantly from one year to another, without reaching the same municipalities in all the exercises, which increases the risk of discontinuity of the actions and hinders the planning of municipal administrations (SILVA et al., 2024).

Regarding the transparency of special transfers, Barbosa (2025), when presenting the results of Sacramento, Raupp and Meincheim (2023), records that the modality emphasizes informational asymmetry and hinders the supervision and control of the resources executed. Barbosa's study also identified action plans that remained in progress for long periods without information about its progress, in addition to management reports with very different levels of detail, some of them without enough elements to adequately demonstrate the application of resources (SACRAMENTO; RAUPP; MEINCHEIM, 2023 apud BARBOSA, 2025).

2.2 Foundations and conditions for applying Benford's Law

Newcomb (1881) observed that the opening pages of logarithm tables were more used than the final ones. Benford (1938) gathered data from different sources and systematized the distribution. For the first digit, the probability decreases from approximately 30.1% for the digit 1 to 4.6% for the 9. The distribution is also defined for the first two digits, from 10 to 99.

An important statistical explanation stems from the scale invariance and the combination of distributions. Hill (1995) showed that mixtures of data from varied processes tend to the law of significant digits. Adhesion is more plausible in positive values that cover various orders of magnitude and result from multiplicative or heterogeneous processes. Numbers assigned, codes, rigidly tabulated prices, narrow limits and small samples may not follow the standard (HILL, 1995; BERGER; HILL, 2015; NIGRINI, 2012).

Applying to public data requires additional caution. Budgets are approved in whole or rounded amounts, programs can impose ceilings and minimums, and the administrative process can concentrate amounts in conventional bands. Therefore, nonconformity does not automatically identify manipulation. it asks a question: why do certain prefixes appear more, less, or concentrate more value than the reference standard? (DURTSCHI; HILLISON; PACINI, 2004; CLEARY; THIBODEAU, 2005).

2.3 Benford's Law in audit selection

In the audit, the first digit offers a broad view, while the first two digits locate more specific ranges. The statistics Z signals discrepancies in each category; the chi-square summarizes the global discrepancy; and the Mean Absolute Deviations (AMD) measures the mean magnitude of the distance. On large basis, measures of significance can react to small differences, which is why financial materiality should be observed together with frequency (NIGRINI; MITTERMAIER, 1997; NIGRINI, 2012).

National studies have applied the law to commitment notes, payment cards and tax audit. These studies show that the procedure can locate atypical concentrations and organize the selection, but reiterate that the alert depends on documentary validation and institutional knowledge (COSTA; SANTOS; TRAVASSOS, 2012; CAVALCANTI, 2014).

Cunha (2013), Cunha and Bugarin (2014, 2015) and Bugarin and Cunha (2015) developed applications to public workstrokes. the booklet of Cunha, Bugarin and Portugal (2016) consolidated this experience in eight stages. The central trait is the confrontation

between the test of the first two digits and the Summation Test: critical categories in both receive top priority; critical categories only in the sum are maintained by their materiality; and critical categories only in the Z remain when they have financial relevance. Coffee, Bugarin and Portugal (2021) applied this logic to another public work and reinforced its usefulness as an instrument of focus.

The value of the model is in the governance of the selection. Parameters are defined before analysis, adjustment steps are limited and financial coverage is known. thus, the team can explain why a stratum entered the sample or not. This transparency is especially useful on seamsbases, in which the diversity of objects requires an objective method to help in the selection of cases to be analyzed.

3 Methodology

As for the approach, the research is quantitative; as for the objectives, descriptive; and, as for the technical, documentary procedures (PRODANOV; FREITAS, 2013). the data source is Siga Brasil, portal of the Federal Senate that gathers data from the Federal Government budget, in the position of July 2026. the full financial years from 2020 to 2025 were selected, from the beginning of the implementation of the modality until the last year ended before the extraction (FEDERAL SENATE, 2026).

Data related to the budget action 0EC2, corresponding to the “Special Transfer”, totaling 41,813 records, all classified as amendments of individual authorship, were used. The unit of analysis is each record of the Liquidated variable (R$).

The 41,813 values add up to R$ 25,897,609,245.25.

3.1 Tests prescribed by the reference method

The methodology observes the procedure of Cunha, Bugarin and Portugal (2016). The first digit test was used for general diagnosis. The sample selection was based on the first two digits test, the Summation Test and the eight-step algorithm.

For a first digit d, between 1 and 9, and for a prefix d, between 10 and 99, the expected probability is $P(d) = \log10(1 + 1/d)$. The observed frequency corresponds to the number of records initiated by the digit or prefix divided by the total observations of the analyzed set.

For the Z test, the absolute value higher than 1.96 was considered critical, corresponding to the level of 5%. As for the chi-square, in the first two digits, the critical values are 15,507 and 112,022, respectively (CUNHA; BUGARIN; PORTUGAL, 2016).

The Mean Absolute Deviations (MDA) was used to measure the overall magnitude of the differences between the proportions observed and those expected by Benford's Law. The indicator was calculated by the following expression: MDA = [sum of |p(o,i) − p(e,i)|, for i from 1 to K] / K. In this expression, K corresponds to the number of categories analyzed; p(o,i) represents the proportion observed in category i; p(e,i) represents the expected proportion for the same category; and the vertical bars indicate that the difference should be considered in absolute value, without a negative sign. For the test of the first two digits, the ranges established in the reference study were adopted: approximate compliance for values below 0.0012; acceptable conformity between 0.0012 and 0.0018; marginally acceptable compliance between 0.0018 and 0.0022; and non-conformity for values higher than 0.0022. The MDA was used to evaluate the general distance from the observed distribution in relation to the expected pattern, and not as an isolated criterion to select the prefixes.

In the Summation Test, the values are grouped by the first two digits. For each prefix, its share of the total value and the difference in relation to 1/90, or 1.11%, is calculated. A prefix is critical when this difference exceeds 0.011. Thus, the test incorporates materiality and prevents a frequent but financially irrelevant discrepancy from receiving automatic priority.

3.2 Eight-step selection algorithm

The selection followed the steps proposed by Cunha, Bugarin and Portugal (2016). Table 1 shows the sequence of the steps.

Table 1 - Steps of the Cunha, Bugarin, and Portugal (2016) algorithm

Step	Action	Application in this study
1	Set parameters	Target of 80% of the amount, with a tolerance of ±5 p.p.; Z = 1.96; summation difference = 0.011.
2	Calculate two first digits	Get frequencies, differences, and Z for prefixes 10 to 99.
3	Perform the Summation Test	Calculate financial contribution and difference from 1/90.
4	Confront the tests	Include sum critics and critics in the Z with financial participation of at least 1/90.
5	Add the selected value	Calculate the financial coverage of the included prefixes.
6	Compare with the target track	If necessary, adjust only the authorized limits, in the prescribed order.

Step	Action	Application in this study
7	Consolidate the sample	Register prefixes, quantity of items, value and coverage.
8	Complementary by ABC Curve	Apply only if the coverage continues below 75% after adjustments.

Source: author's elaboration based on Cunha, Bugarin, and Portugal (2016, p. 32).
Note: The authors originally apply the method to financial spreadsheets. Here, it was adapted to settled expenditures.

The procedure adopted as a reference the coverage of 80% of the total value, admitting a variation of five percentage points. In addition, the results between 75% and 85% were considered appropriate. In the initial application, the parameters Z = 1.96 and critical difference of the sum equal to 0.011 were used.

In the confrontation, every critical prefix in the Summation Test is included. Among the critical prefixes in the Z are included only those whose financial contribution is at least 1/90 of the total. The intersection of the two tests forms the top priority. The union between the critics of the sum and the critics in the Z with financial relevance forms the initial sample.

When the coverage is below 75%, Cunha, Bugarin and Portugal (2016) determine to successively reduce the limit of the difference in the sum to 0.00825, 0.0055 and 0.00275. Persisting insufficiency, the limit of Z can be reduced to 1.64, equivalent to 10%. If the coverage still remains below the track, the sample should be supplemented by the ABC Curve. As the aggregate set reached 77.11% with the basic parameters, no adjustment or complement was applied to it.

3.3 Analytical breakdowns

The procedure was repeated in each region that gathered at least 800 records, a minimum number predicted by the model. All regions met this criterion: North, Northeast, Central-West, Southeast and South. The 661 records without regional identification remained in the aggregate analysis, but did not enter the comparisons between regions. The same criterion was adopted for the expenditure nature groups (DNG).

Current expenditure and investments were therefore examined. The six records classified as financial inversions were kept in the general set, but were outside the analysis by GND.

The amount Settled (R$) informs the value recognized by the Federal Government as executed. Thus, this data alone does not allow to know how the beneficiary entity applied the

resources, whether the work plan was fulfilled or whether the intended object was effectively delivered.

It is noteworthy that the confirmation of a possible finding depends on the cross-breeding with other sources, such as extracts from the specific account, hiring processes, invoices, measurement bulletins and physical inspections, selected according to the investigated aspect.

4 Results and discussion

4.1 Dataset composition

Records grew over the period, with annual swings and higher concentration between 2023 and 2025, especially in 2024.

Table 2 shows the distribution of the records:

Table 2 - Annual distribution of the records analyzed

Year	Records	Share
2020	1.808	4,32%
2021	4.843	11,58%
2022	3.874	9,27%
2023	9.651	23,08%
2024	11.671	27,91%
2025	9.966	23,83%
Total	41.813	100,00%

Source: author's elaboration based on Siga Brasil data (FEDERAL SENATE, 2026).

In addition to the analysis of the set of records, it was also unfolded by region and by group of nature of the expense.

4.2 Aggregate diagnosis and sample selection

In the first digit, the chi-square was 3,415.48 and the MDA, 0.02485. All nine digits had a Z higher than 1.96. The result indicates nonconformity.

In the first two digits test, the chi-square reached 97,875.41, far above the critical value of 112,022, and the MDA was 0.01207, above the non-conformity limit of 0.0022. Of the 90 prefixes, 87 presented critical Z. The size of the set contributes to the sensitivity of the Z and

the chi-square; therefore, the selection was not based only on these values and incorporated the Soma Test, as determined by Cunha, Bugarin and Portugal (2016).

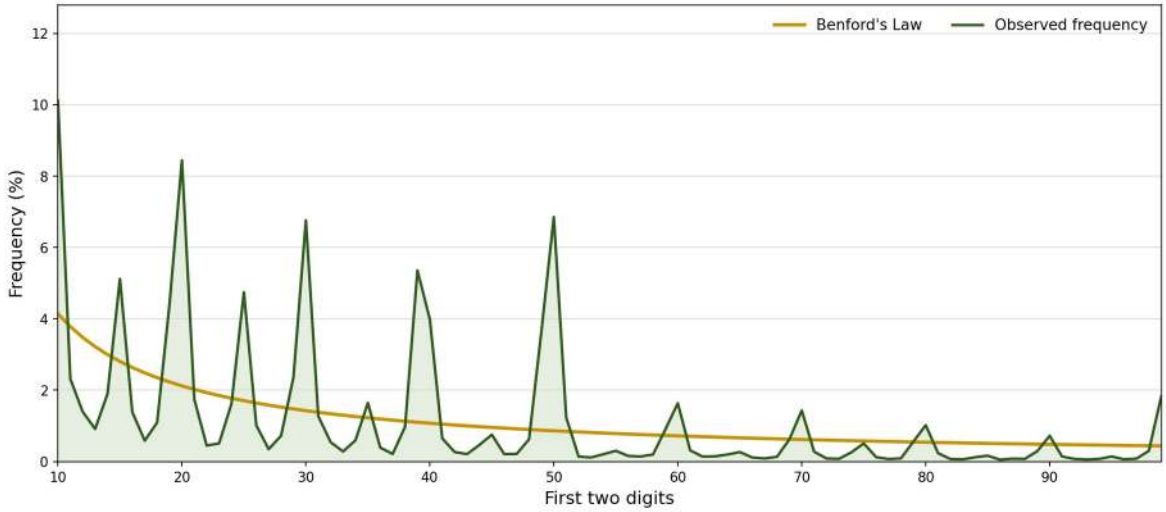
Table 3 - Aggregate results

Procedure	Categories	Chi-square	MDA	Result
First digit	9	3415,48	0,02485	Nonconformity
First two digits	90	97875,41	0,01207	Nonconformity

Source: author's elaboration based on Siga Brasil data (FEDERAL SENATE, 2026).

Figure 1 shows a higher concentration in prefixes associated with round values, in addition to deviations in some intermediate bands. Prefix 10, for example, gathered 12.24% of the records, almost three times the expected frequency of 4.14%. Relevant differences also appear in prefixes 20, 30, 39 and 50. A possible explanation is the recurring use of previously defined or rounded values in the drafting of the amendments.

Figure 1. Observed and expected frequencies of the first two digits



Source: author's elaboration based on Siga Brasil data (FEDERAL SENATE, 2026).

The Summation Test identified 12 critical prefixes: 10, 14, 15, 19, 20, 25, 30, 39, 40, 49, 50 and 99, as shown in Table 4. All were also critical in the Z test and therefore made up the top priority. 12 other prefixes were critical in the Z and achieved financial participation of at least 1/90: 11, 12, 13, 16, 17, 18, 24, 29, 35, 60, 70 and 80. The union resulted in 24 selected prefixes.

These prefixes comprise 35,424 records, or 84.72% of the observations, and R$ 19.97 billion, or 77.11% of the settled amount. coverage is within the range of 75% to 85%.

Table 4 details the prefixes classified as of top priority, that is, those that simultaneously presented statistically relevant deviation in the Z test and critical financial participation in the Summation Test. This cross between the various categories with deviations from the Benford

distribution, those that also concentrate a significant portion of the values settled. The ordering by the financial participation shows which prefixes should receive initial attention in the planning of the audit, without their inclusion in the sample implying, by itself, any conclusion on irregularity, error or inadequacy in the execution of the transfers.

Table 4 - Highest-priority prefixes, ordered by financial share

Prefix	Observed freq.	Benford freq.	Z	Share of amount
10	12,24%	4,14%	83,15	10,07%
20	9,61%	2,12%	106,41	7,10%
50	7,86%	0,86%	155,07	6,64%
30	7,80%	1,42%	110,04	5,64%
39	6,07%	1,10%	97,39	4,52%
15	5,85%	2,80%	37,67	4,11%
40	4,36%	1,07%	65,29	3,82%
99	2,14%	0,44%	52,89	3,71%
49	3,48%	0,88%	57,14	3,47%
19	4,16%	2,23%	26,74	3,43%
25	5,44%	1,70%	59,05	3,14%
14	1,31%	3,00%	20,26	2,61%

Source: author's elaboration based on Siga Brasil data (FEDERAL SENATE, 2026).

The 12 top priority prefixes concentrate 29,406 records and 58.25% of the total value. The top priority is determined because there was a simultaneous indication of a critical prefix in the Z Test and the Summation Test. The prefix 10 alone gathers 10.07% of the amount; the prefixes 20, 50 and 30 gather, respectively, 7.10%, 6.64% and 5.64%. For an audit, this group is the first stratum to be explained, because it combines frequency deviation and materiality above the sum limit.

4.3 Results by region

According to Table 5, the distribution by region showed a higher number of records in the Northeast, Southeast and South.

Table 5 - Results by beneficiary region

Region	n	BRL millions	MDA	Prefixes	Coverage	Status
North	5.155	4.933,14	0,01072	26	75,41%	Target range achieved
Northeast	11.912	9.073,34	0,01118	21	73,80%	ABC curve required
Central-West	2.614	1.913,30	0,01168	24	75,71%	Target range achieved
Southeast	10.832	5.681,46	0,01256	23	76,93%	Target range achieved
South	10.639	3.925,47	0,01352	18	78,45%	Target range achieved
Not regionalized	661	370,89	n.a.	n.a.	n.a.	n < 800

Source: author's elaboration based on Siga Brasil data (FEDERAL SENATE, 2026).

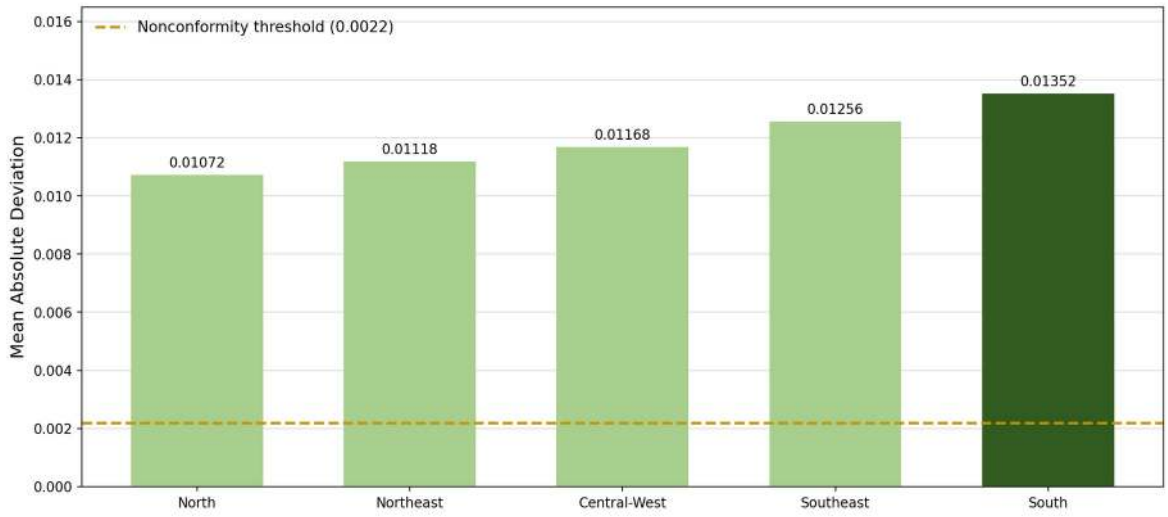
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The investments (GND 4) accounted for 34,864 records and R$ 22.59 billion, equivalent to 83.38% of the observations and 87.23% of the value. Other current expenses (GND 3) gathered 6,943 records and R$ 3.30 billion; GND 5 was residual.

All five regions have more than 800 records and presented MDA greater than 0.0022. The highest MDA was observed in the South (0.01352), followed by Southeast (0.01256), Central-West (0.01168), Northeast (0.01118) and North (0.01072). The order describes the mean intensity of the deviations in each distribution.

Regarding the MDA by region, according to the illustration in Figure 2, the North, Central-West, Southeast and South regions reached the target range, with coverages of 75.41%, 75.71%, 76.93% and 78.45%. The Northeast reached 72.30%. The first two reductions of the sum limit did not modify the selection; the reduction to 0.00275 raised the coverage to 73.80%, still below 75%, and the adoption of Z = 1.64 did not add prefixes.

Figure 2. Mean Absolute Deviation by region



Source: author's elaboration based on Siga Brasil data (FEDERAL SENATE, 2026).

The 661 non-regionalized records, in the amount of R$ 370.89 million, were not submitted to the regional test due to sampling insufficiency. they remained in the aggregate diagnosis.

4.4 Results by expenditure category

According to Table 6 indicates, current expenses and investments also presented nonconformity. In GND 3, the chi-square was 13,454.34 and the MDA, 0.01145. The basic sample collected 22 prefixes and 70.62% of the value; the reductions in the sum limit and the adoption of Z = 1.64 did not increase the selection. Thus, a work restricted to this universe

would need to advance to the ABC Curve to achieve minimum coverage, according to the reference model.

As for investments, the chi-square was 87,887.33 and the MDA, 0.01229. Twenty-three prefixes covered 76.83% of the value and 29,377 records, reaching the target range with the basic parameters. The six records of the GND 5 amounted to R$ 3.74 million and were not tested separately, but remained in the aggregate set.

The MDA of the investments was greater than that of current expenditure. In practice, investments deserve attention for the combination of financial predominance and nonconformity, while current expenses require ABC complement if they constitute an isolated scope, since it did not stand between the coverage range stipulated by the model, which is 75% to 85%.

Table 6 - Results by expenditure category

GND	n	BRL millions	Chi-square	MDA	Prefixes	Coverage	Status
3 - Other current expenses	6.943	3.303,57	13454,34	0,01145	22	70,62%	ABC curve required
4 - Investments	34.864	22.590,30	87887,33	0,01229	23	76,83%	Target range achieved
5 - Financial inversions	6	3,74	n.a.	n.a.	n.a.	n.a.	n < 800

Source: author's elaboration based on Siga Brasil data (FEDERAL SENATE, 2026). Note: n.a. = not applicable.

For audit planning, the concentration on prefixes indicates that the values depart from the standard of Benford's Law. This does not make irregular, in itself, the 35,424 records selected; it only defines a set to examine. Round values may reflect limits of programs, installments or practices of budget preparation. The team should verify beneficiary, author, exercise, object and stage of execution, comparing this information with work plans, specific accounts and local documents.

5 Final considerations

This study aimed to analyze the behavior of the settled amounts of the Pix amendments in the period from 2020 to 2025 in relation to Benford's Law and identify the priority strata for the selection of audit samples, through the application of the method of Cunha, Bugarin and Portugal (2016). For this, 41,813 records were examined, evaluating the conformity of the distribution of the first two digits with the expected mathematical standard and applying objective criteria of frequency and financial relevance for the delimitation of the sample.

It was found that the distribution of the first two digits showed a strong distance from the expected pattern, with a chi-square of 97,875.41 and MDA of 0.01207. The confrontation between the Z statistic and the Summation Test selected 24 prefixes, corresponding to 35,424 records and 77.11% of the analyzed value. as the coverage was between 75% and 85%, it was not necessary to adjust the parameters or apply the ABC Curve. Twelve prefixes simultaneously gathered frequency and sum criticality, constituting the top priority for later examinations.

Among the regions, the amendments destined to the South should be prioritized because they present the greatest deviation of the mathematical standard. As for the nature of the expenditure, the priority should fall on investments (GND 4), which combined financial predominance and MDA of 0.01229. North, Central-West, Southeast, South and investments achieved minimum coverage with basic parameters.

The main contribution of the study is to demonstrate that Benford's Law, when applied through previously defined rules, can support the delimitation of samples on extensive bases of special transfers. The procedure makes explicit the criteria for the inclusion of the records and allows to order the strata according to the intensity of the deviations and their financial relevance. Thus, the results offer a replicable subsidy to the planning of audits, especially in contexts in which the examination of the data population is unfeasible.

It should be noted that the results do not prove fraud, illegality or improper application of resources. Deviations constitute warning signs and should guide further analyses, without replacing professional judgment or other planning criteria, such as materiality, auditor experience, object history, risks and denunciations. Selected records must be confronted with work plans, specific accounts, hiring and delivery evidence.

Future research can validate the alerts through documentary examinations and verify the stability of the prefixes in new extractions, as well as evaluate other cutouts, such as the beneficiary State or municipality, preserving the rules used in sample formation.

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