UNVEILING THE BRACKET CREEP: STATIC VERSUS DYNAMIC FISCAL DRAG

José Félix Sanz Sanz*
María Arrazola Vacas†

* Corresponding autor. E-mail: jfsanzsa@ucm.es. Departamento de Economía Aplicada e Instituto Complutense de Análisis Económico (ICAE), Universidad Complutense de Madrid (Campus Somosaguas), Pozuelo de Alarcón 28223.
† Universidad Rey Juan Carlos

Abstract:

This paper develops a simple model that accurately quantifies the surtax of not indexing the personal income tax schedule(s) in inflationary scenarios and the corrective compensation in case of total or partial indexing. The model is developed for the individual taxpayer and the population aggregate and identifies two different components within the bracket creep, one static, linked to the pre-inflation taxable income, and the other dynamic, associated with changes in the taxable income. Finally, an empirical application of the model to the case of Spain for 2022 is provided. The findings from this empirical analysis demonstrate that the decision not to index the tax schedule will impose an additional tax of over 1,187 million euros on Spanish taxpayers, of which 94% (1,114 million) corresponds to static bracket creep and the remainder (74 million) to the dynamic component. Paradoxically, although the static component is significantly larger, bracket creep continues to be defined in the literature in terms of its dynamic component.

JEL codes : H20, H24, D31, D63.
Keywords: bracket creep, inflation, personal income tax.

1. INTRODUCTION

The resurgence of inflation in 2021 and 2022 has reignited interest in its effects on fiscal systems. Economists have long acknowledged that inflation influences tax revenue and reshapes the distribution of the tax burden, often through mechanisms that operate automatically, without explicit government intervention. These effects are particularly pronounced in progressive taxes, such as the Personal Income Tax (PIT), where revenue elasticity exceeds unity.

One of the primary vulnerabilities of PIT to inflation lies in its structural design. Various tax components are defined in nominal terms and, if not appropriately adjusted, their real value erodes due to rising prices. Inflation affects taxable income not only by altering its nominal and real values but also by distorting multiple elements of the PIT that determine the effective tax burden. Among these, fixed monetary deductions, allowances, and tax credits lose their real value over time, diminishing their effectiveness in providing tax relief. Similarly, inflation can affect tax-exempt income thresholds, altering the share of income subject to taxation. Moreover, certain non-indexed benefits and exemptions embedded in the tax system may become increasingly restrictive as nominal incomes rise, leading to unintended changes in tax liability. In addition to these distortions, inflation also affects the tax rate schedule of PIT, which dictates the progression of both average and marginal tax rates across different income levels. While all these interactions between inflation and PIT are relevant, this paper focuses specifically on the impact of inflation on the tax schedule. By isolating this aspect, we aim to provide a precise and analytically rigorous assessment of how inflation-induced distortions emerge, distinguishing their static and dynamic components.

A well-documented consequence of this interaction is what the literature commonly refers to as bracket creep or fiscal drag. For the purposes of this paper, both terms will be used interchangeably. This phenomenon occurs when nominal income increases to offset inflation, pushing taxpayers into higher tax brackets and increasing their tax liability, even if their real income remains unchanged. However, this conventional definition may be misleading, as it suggests that bracket creep results exclusively from the nominal increase in taxable income. In reality, bracket creep occurs even when taxable income remains unchanged—or even declines—due to the failure to adjust monetary thresholds. This distinction highlights two separate components of bracket creep. The dynamic component stems from changes in taxable income as individuals adjust their nominal earnings in response to inflation. The static component, by contrast, arises purely from inflationary erosion within a non-indexed tax structure, regardless of income adjustments.

The primary contribution of this paper is to formally model these two components and demonstrate their relative magnitudes. While previous studies have primarily focused on the dynamic component, the static component has been largely overlooked, despite its systematic importance in shaping the inflationary impact on PIT. Although the static component is normally systematically larger, the debate on bracket creep has traditionally centered on its dynamic component, neglecting a fundamental driver of inflation-induced distortions in PIT.

Our model captures bracket creep at both individual and aggregate levels. To illustrate its applicability, we quantify the extent of bracket creep resulting from the absence of indexation in the Spanish Personal Income Tax (IRPF) during the inflationary surge of 2021 and 2022.

The remainder of the paper is structured as follows. Section 2 reviews the literature on inflation and PIT. Section 3 presents the formal model. Section 4 applies the model empirically to the Spanish case and examines its distributive implications. Finally, Section 5 concludes with key findings and policy consideration

2. LITERATURE REVIEW

The robust inflation rates experienced during the 1970s spurred a vast body of literature examining the bracket creep phenomenon. Initial studies predominantly investigated the impact of inflation on income tax collection and progressivity. Additionally, considerable attention was devoted to analysing the efficacy of measures such as the indexation of rate schedules, allowances or deductions that were implemented in numerous countries to mitigate the repercussions of elevated inflation.

The studies examining the effect of bracket creep on the progressivity of the income tax found evidence of its regressive impact, with a much greater increase in the tax burden due to inflation observed among low-income earners (Buchanan and Dean, 1974; Von Furstenberg, 1975; Nowotny, 1980; Tatom, 1985), depending on the existing deductions and how they were modified by inflation (Goetz and Weber, 1971; Vukelich, 1972; Bossons and Wilson, 1973; Arak, 1976; Tanzi, 1980). The literature also demonstrated evidence of an increase in revenue due to bracket creep, although adjustments to the tax schedule made to offset the inflationary effect were able to reduce it (Buchanan and Dean, 1974; Grady and Stephenson, 1977) and enhance progressivity (Allan, Dodge, and Poddar, 1974). Similarly, both the increase and indexation of deductions could offset the inflationary effect, especially among taxpayers with moderate and low incomes, thus contributing to the restoration of progressivity (Von Furstenberg, 1975; Jarvis and Smith, 1977; Tatom, 1985). However, the evidence was not conclusive, as some studies suggested that adjusting the tax schedule and deductions did not completely eliminate the bracket creep effect (Buchanan and Dean, 1974; Jarvis and Smith, 1977; Morgan, 1977; Gillingham and Greenless, 1990; Altig and Carlstrom, 1991). Years later, when revenue increases became necessary to cover deficits in the 1980s, some authors examined the capacity of bracket creep as a revenue-raising tool (Altig and Carlstrom, 1993).

From a methodological standpoint, the studies in this initial phase exhibit considerable diversity. While some merely elucidated the bracket creep issue through illustrative examples or analysed existing evidence along with potential solutions (Buchanan and Dean, 1974; Nowotny, 1980), the majority conducted calculations to assess the effects of inflation or indexation under various tax structures. These calculations were often tailored to individuals with differing allowances and deductions or examined in different timeframes, both before and after-tax reforms[1]. Furthermore, during this early phase, some studies employed macro-econometric models to conduct their analyses, incorporating tax reforms and diverse scenarios of indexation or inflation (Bossons and Wilson, 1973; Grady and Stephenson, 1977). Others utilised microsimulation (Allan, Dodge, and Poddar, 1974; Gillingham and Greenless, 1990), general equilibrium models of overlapping generations (Altig and Carlstrom, 1993), or, like the study by Hutton and Lambert (1981), who developed a mathematical model to ascertain the elasticity of tax revenue in relation to income. For the case of Spain, Argimón and González Páramo (1987) likewise employ a simplified model to estimate a function of effective tax rates, assuming a uniform distribution of taxpayers' taxable incomes within each bracket. This approach enables them to calculate the tax burden and its distribution across income levels, addressing the challenges associated with the utilisation of aggregate data present in previous studies.

However, once the high inflation rates that had led to this proliferation of literature in the 1970s and early 1980s were overcome, interest in analysing the effects of bracket creep waned. The low inflation rates of the 1990s relegated the topic to the background until a resurgence in its study occurred in the last 25 years. This resurgence can be attributed not only to the development and enhancement of tax microsimulation but also to the interest in investigating whether, with most countries abandoning the indexation of their tax systems, there has been an increase in the tax burden and a decrease in progressivity despite the low inflation rates during those years. It was also necessary to analyse whether tax reforms undertaken in some countries, which had transformed the structure of the income tax, had reduced bracket creep.

In line with the research from the initial phase, literature employing microsimulation techniques has predominantly focused on assessing whether bracket creep affects the progressivity, redistributive capacity, and revenue-raising potential of the income tax (Immervoll, 2005; Levy et al., 2010; Flores and Zhu, 2014; Zhu, 2015). Conclusions drawn suggest a reduction in progressivity and an increase in revenue, potentially enhancing the redistributive capability of the tax. Additionally, some studies investigate the impact of indexation on progressivity and efficiency (Jordaan and Schoeman, 2018; Paulus et al., 2020), compare the effects of bracket creep with those of tax reforms (Gastaldi, Liberati, and Rapallini, 2008), or propose and analyse tax models aimed at mitigating the effects of bracket creep (Dorn et al., 2017; Estévez and Sommer, 2020).

Although most studies over the past 25 years have relied on microsimulation, some authors have analysed the redistributive or revenue effects of bracket creep using alternative methodologies. For instance, Heineman (2001) estimates a panel data model, Heer and Süssmuth (2013) employ a general equilibrium model of overlapping generations, Nam and

[1] See, for example, Goetz and Weber (1971), Vukelich (1972), and Jarvis and Smith (1977), who analyze the intertemporal structure of tax rates; Von Furstenberg (1975), who computes effective tax rates and income elasticities of taxes; Arak (1976), who examines the variation in the average tax rate caused by price increases; or Altig and Carlstrom (1991), who construct hypothetical time series of marginal tax rates under different tax structures.

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Zeiner (2016) calculate the elasticity of net income with respect to taxable income, Süssmuth and Wieschemeyer (2022) estimate a BES regression model, and Baldini (2021) utilises iterative methods with microdata.

The recent surge in inflation since 2021, reaching levels not seen in decades in many regions, has rekindled interest in the effects of bracket creep and potential indexation mechanisms (Bankowski et al., 2023; Beer et al., 2023; Garcia-Macia, 2023; OECD, 2023). Several studies, using microsimulation models, have analyzed the impact of this inflationary episode across different countries, finding evidence of increased tax revenue driven by bracket creep (Balladares & García-Millares, 2024; Leventi et al., 2024).

However, despite the methodological advancements in recent years, and although tax microsimulation, which has been the most widely used methodology, accurately quantifies the consequences of inflation, it has the drawback of functioning as a "black box" in which the mechanisms of interaction between inflation and tax schedules are obscured. This deficiency underscores the need to expand the literature with studies that employ mathematical modelling, such as the one presented in this paper, which analytically elucidates the channels of this interaction, facilitating an understanding of what bracket creep is and how it occurs.

3. THE MODEL

Inflation affects PIT by altering both the taxable income and the structure of tax liabilities. To formalize this impact, we define the PIT function as $T = T(y, \zeta)$, where y represents taxable income and ζ denotes the tax schedule, which determines how different income levels are taxed. The tax schedule consists of a set of increasing marginal tax rates and income thresholds that define the progressive structure of PIT. Specifically, the tax schedule is represented as $\zeta = \zeta(\vec{A}, \vec{\tau})$, where $\vec{\tau} = (\tau_0, \tau_1, \dots, \tau_k)$ is the vector of marginal tax rates applied sequentially to y, according to the income thresholds defined in $\vec{A} = (a_0, a_1, \dots, a_k)$. Since PIT is typically progressive, the tax schedule follows a piecewise linear structure, meaning that each segment of taxable income is taxed at increasing marginal rates according to predefined thresholds. This formulation aligns with most PIT structures worldwide.[2]

We further assume that over n years of tax implementation, inflation accumulates at rate π, which is computed as $\pi = \prod_{l=1}^{n}(1 + \pi_l) - 1$. In response, taxpayers adjust their taxable income—whether through wage negotiations, business adjustments, or investment returns—at a rate π^0 over these n years to preserve their purchasing power.

[2] While most PIT systems follow a piecewise linear structure with discrete tax brackets and increasing marginal rates, alternative tax schedule designs also exist. Notably, Germany employs a continuous and smooth marginal tax rate function, where tax rates increase progressively without abrupt jumps at predefined thresholds. This system is designed to avoid sharp distortions at bracket cutoffs, ensuring a more gradual transition in marginal tax burdens as income rises.

In this context, inflation affects tax revenue through two primary mechanisms: first, by altering taxable income as individuals adjust their earnings in response to rising prices; and second, by influencing the tax schedule, particularly the position of marginal rates and tax brackets. Therefore, mathematically, the total impact of inflation on PIT revenue can be expressed as follows:

$$\frac{dT}{d\pi} = \frac{\partial T}{\partial y} \cdot \frac{dy}{d\pi} + \frac{\partial T}{\partial \zeta} \cdot \left[\frac{\partial \zeta}{\partial \vec{\tau}} \cdot \frac{d\vec{\tau}}{d\pi} + \frac{\partial \zeta}{\partial \vec{A}} \cdot \frac{d\vec{A}}{d\pi}\right] \quad [1]$$

The first right-hand term, $\frac{\partial T}{\partial y} \cdot \frac{dy}{d\pi}$, represents the change in tax revenue resulting from taxpayers adjusting their nominal income in response to inflation. This effect, that we refer to as dynamic bracket creep, occurs because nominal income growth may push taxpayers into a higher tax bracket, increasing their tax burden even if their real income declines or remains unchanged.

The second right-hand term, $\frac{\partial T}{\partial \zeta} \cdot \left[\frac{\partial \zeta}{\partial \vec{\tau}} \cdot \frac{d\vec{\tau}}{d\pi} + \frac{\partial \zeta}{\partial \vec{A}} \cdot \frac{d\vec{A}}{d\pi}\right]$, captures the revenue effect resulting from changes (or lack thereof) in the tax schedule. If no adjustments are made to tax thresholds or marginal tax rates, this term represents what we call static bracket creep. In this case, inflation erodes the real value of fixed tax brackets, effectively narrowing them and increasing the average tax burden on taxpayers, even without any policy changes. In interpreting [1], it is important to consider the following considerations:

- Since income taxes are levied on nominal income, any increase in taxable income ($\frac{dy}{d\pi} > 0$) will be fully taxed, even if the taxpayer's real purchasing power remains unchanged or declines. This is a key driver of dynamic bracket creep, as inflation can push individuals into a higher tax bracket despite no real improvement in their economic capacity.

- Inflation reduces the real width of tax brackets when thresholds remain fixed in nominal terms, increasing effective tax burdens. To maintain the real progressivity of the tax, an inflation-proof tax schedule must adjust all thresholds proportionally. In year n, this would be: $\zeta_n^{\pi} = \zeta(\vec{A}^{\pi}, \vec{\tau})$,where $\vec{A}^{\pi} = [a_0 \cdot (1+\pi), a_1 \cdot (1+\pi), \dots, a_k \cdot (1+\pi)]$. This adjustment ensures that tax brackets retain their original real values, preventing artificial tax increases due to inflation.[3]

- Adjusting marginal tax rates reduces overall tax liability but does not specifically correct bracket creep, as it does not restore taxpayers to their pre-inflation tax position. Therefore, as mentioned above, a true correction requires maintaining

[3] This procedure affects only those taxpayers who are susceptible to bracket creep, making it the genuine method of counteracting the effects of inflation on the rate schedule.

original marginal rates, $\frac{d\vec{\tau}}{d\pi} = 0$, and adjusting all tax brackets proportionally to inflation to prevent real bracket compression.

By taking these considerations into account, [1] can be rewritten in a more compact form as follows:

$$\frac{dT}{d\pi} = \frac{\partial T}{\partial y} \cdot \pi^0 y + \frac{\partial T}{\partial \zeta} \cdot \frac{\partial \zeta}{\partial \vec{A}} \cdot \frac{d\vec{A}}{d\pi} \qquad [2]$$

Building on this formulation and explicitly modeling the tax function T, we now derive the analytical expressions of Equation [2] for both individual taxpayers and the overall population. The following subsections present these derivations: first, by examining how bracket creep affects a single taxpayer, and then by extending the analysis to evaluate its broader impact on total tax revenue.

3.1 The bracket creep on the individual taxpayer

Let y_i be the taxable income of taxpayer i taxed in year 0 by the rate schedule $\zeta_0 = \zeta_0(\vec{A}, \vec{\tau})$, with $\vec{\tau} = (\tau_0, \tau_1, \dots, \tau_k)$ and $\vec{A} = (a_0, a_1, \dots, a_k)$. Following Creedy and Gemmell (2006), the gross tax liability resulting from applying ζ_0 on y_i can be expressed as:

$$T_i = \tau_{k_i} \cdot \left(y_i - a'_{k_i}\right) \qquad [3]$$

where τ_{k_i} is the taxpayer's maximum marginal rate and a'_{k_i} its effective threshold, defined as $a'_{k_i} = \sum_{j=0}^{k_i} a_j \cdot \frac{(\tau_j - \tau_{j-1})}{\tau_{k_i}}$.

Therefore, taking into account [2] and [3], the level of bracket creep that an individual taxpayer will bear in year n in the absence of schedule indexation will amount to:

$$dT_i = \overbrace{\left[\tau^{n,}_{\pi^0 y}(\vec{A}) - \tau^{n,}_{\pi^0 y}(\vec{A}^{\pi})\right] \cdot \pi^0 \cdot y_i \cdot d\pi}^{\Delta T_i^D} + \overbrace{\left[\frac{\partial T_i}{\partial \tau_{k_i}} \cdot \frac{\partial \tau_{k_i}}{\partial \pi} + \sum_{j=0}^{k-1} a_j \cdot \pi_j \cdot (\tau_j - \tau_{j-1})\right] \cdot d\pi}^{\Delta T_i^S} \qquad [4]$$

This expression distinguishes between the two components of bracket creep: the dynamic component (ΔT^D) and the static component (ΔT^S). The dynamic component represents the inflationary surtax applied to the increase in taxable income, $\pi^0 y_i$, while the static component captures the additional tax burden borne by the initial taxable income, y_i , regardless of any income growth.

The computation of ΔT_i^D depends on the difference in marginal tax rates applied to the income increase under two scenarios: without indexation, where the applicable marginal tax rate is $\tau^n_{\pi^0 y}(\vec{A})$, and with indexation, where the adjusted marginal tax rate is $\tau^n_{\pi^0 y}(\vec{A}^{\pi})$. On the other hand, the quantification of ΔT_i^S consists of two elements: the static bracket creep generated within the tax bracket where the taxpayer's taxable income falls, captured by $\frac{\partial T_i}{\partial \tau_{k_i}} \cdot \frac{\partial \tau_{k_i}}{\partial \pi}$, and the cumulative static bracket creep across all preceding $k-1$ tax brackets, given by $\sum_{j=0}^{k-1} a_j \cdot \pi_j \cdot (\tau_j - \tau_{j-1})$.

In full indexation, the indexation rate π_j must be uniform across all brackets and equal to π, meaning that $\pi_j = \pi$ for every j. However, we retain the individualized notation π_j to account for potential fiscal policy decisions where tax authorities might choose to index different brackets at varying rates, rather than applying a uniform adjustment across the entire tax schedule[4].

The individual static bracket creep (ΔT_i^S)

Equation [4] establishes that ΔT_i^S corresponds to the algebraic sum of the marginal tax burden differentials arising from the absence of indexation, as applied to y_i across the various tax brackets it traverses within the tax schedule. Specifically, in each of the first $k-1$ tax brackets, this additional tax liability is given by $a_j \pi_j (\tau_j - \tau_{j-1})$, reflecting the extent to which unadjusted thresholds increase the effective tax burden due to inflation. In contrast, for the last bracket, k_i, the static bracket creep depends, as indicated in Equation [5], on the relative position of y_i with respect to the inflated threshold of the final bracket, $a_{k_i} \cdot (1+\pi)$:

$$\frac{\partial T_i}{\partial \tau_{k_i}} \cdot \frac{\partial \tau_{k_i}}{\partial \pi} \begin{cases} a_{k_i} \cdot \pi_j \cdot (\tau_k - \tau_{k-1}) & \text{if} \quad y_i \geq a_{k_i} \cdot (1+\pi) \\ (y_i - a_{k_i}) \cdot (\tau_k - \tau_{k-1}) & \text{if} \quad y_i < a_{k_i} \cdot (1+\pi) \end{cases} \quad [5]$$

This formulation highlights the differential impact of non-indexation depending on the taxpayer's position within the tax schedule. When taxable income exceeds the inflated threshold of the final bracket, the marginal tax burden in that bracket follows the standard indexation gap effect. Conversely, when y_i remains below the adjusted threshold, the tax surcharge is a function of the portion of income exposed to the next tax bracket, which remains unindexed.

[4] For example, in Spain during 2023, some political parties proposed adjusting only the first three brackets of the tax schedule, rather than fully indexing all brackets. In such cases, Equation [4] can be used to measure the effects of partial indexation by comparing it to a full indexation scenario, where all tax brackets are adjusted proportionally to actual inflation, ($\pi_j = \pi$ for every j).

Therefore, the level of total static bracket creep that any individual taxpayer will bear, ΔT_i^S, will amount to:

$$\Delta T_i^S = \sum_{j=0}^{k} \pi_j \cdot (\tau_j - \tau_{j-1}) \cdot a_j \qquad if \quad y_i \geq a_k \cdot (1+\pi)$$
$$\Delta T_i^S = \sum_{j=0}^{k-1} \pi_j \cdot (\tau_j - \tau_{j-1}) \cdot a_j + (\tau_k - \tau_{k-1}) \cdot (y_i - a_k) \qquad if \quad y_i < a_k \cdot (1+\pi) \qquad [6]$$

Namely, the cumulative static drag borne by a taxpayer depends on the number of tax brackets through which their taxable base passes. Consequently, in taxes with tiered rates, the wealthier the taxpayer, the greater the economic detriment caused by the absence of indexation, and hence, the greater the generated bracket creep. Equation [6] also highlights that static bracket creep depends on the rate structure, as it not only increases with the inflation rate but also with the number of tax brackets, the differential between marginal rates, and the magnitude of the income thresholds. Conversely, it decreases with the bracket width. Furthermore, it is important to note that static bracket creep is independent of π^0, indicating that ΔT^S occurs automatically regardless of the post-inflationary dynamics of the taxable income.

The individual dynamic bracket creep (ΔT_i^D)

Regarding dynamic bracket creep, if the taxpayer manages to increase his nominal taxable income by a factor of π^0, the resulting income increment, $\pi^0 y_i$ will bear the full tax. ΔT_i^D identifies the differential tax burden borne by $\pi^0 y_i$ in the absence and presence of indexation. As shown in [4], the magnitude of ΔT_i^D depends on the marginal rates $\tau^n_{\pi^0 y}(\vec{A})$ and $\tau^n_{\pi^0 y}(\vec{A}^\pi)$, whose values are linked to the relative position within bracket k_i occupied by the initial taxable income, y_i, and the inflated taxable income, $y_i \cdot (1+\pi^0)$. As depicted in Figure 1, in any indexed bracket, three critical zones can be distinguished: A, B, and C. Zone A corresponds to the area bounded between the lower threshold of the bracket and its indexed value — $A \in [a_j, a_j(1+\pi)]$–, while $B \in]a_j(1+\pi),\ a_{j+1}]$ and $C \in]a_{j+1},\ a_{j+1}(1+\pi)]$.[5]

[5] While this analysis defines three primary zones (A, B, and C) to classify taxpayer transitions in dynamic bracket creep, it is theoretically possible for taxable income to increase sufficiently to bypass multiple adjacent brackets, creating additional transition zones. However, such occurrences are rare and would generally require exceptionally high nominal income growth relative to bracket widths. In most practical settings, the three identified zones provide a robust framework that captures the vast majority of cases. Moreover, in the empirical application presented in Section 4, all observed instances fall within these three zones, reinforcing the validity and sufficiency of this classification.

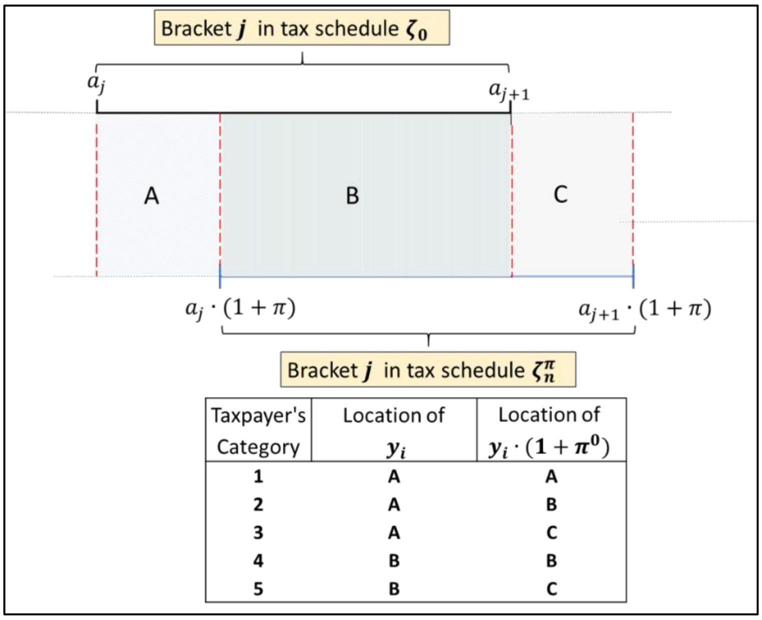

Figure 1: The three critical areas resulting from indexing bracket j and characterization of the five categories of taxpayers based on the location of y_i and $y_i \cdot (1+\pi^0)$.

The classification of taxpayers within these zones is determined by the relative positioning of y_i and $y_i \cdot (1+\pi^0)$ with respect to the three defined areas. Based on these criteria, taxpayers can be categorized into five distinct groups, as summarized in Table 1. Since the original taxable income, y_i, must necessarily fall within the range $[a_j, a_{j+1}]$, it follows that only zones A and B can contain y_i. However, after indexation, the adjusted taxable income $y_i \cdot (1+\pi^0)$ can occupy all three zones if $a_j < y_i \leq a_j \cdot (1+\pi)$ or only zones B and C in the event that $a_j \cdot (1+\pi) < y_i \leq a_{j+1}$.

Table 1. Categories of taxpayers based on the magnitudes and relative positions of $\mathrm{y_i}$ and $\mathrm{y_i} \cdot (1+\pi^0)$ for the calculation of ΔT_i^D.*

y_i	$y_i \cdot (1+\pi^0)$	Category
$a_j < y_i \leq a_j \cdot (1+\pi)$ Zone A	$a_j < y_i \cdot (1+\pi^0) \leq a_j \cdot (1+\pi)$ Zone A	1
	$a_j \cdot (1+\pi) < y_i \cdot (1+\pi^0) \leq a_{j+1}$ Zone B	2
	$a_{j+1} < y_i \cdot (1+\pi^0) \leq a_{j+1} \cdot (1+\pi)$ Zone C	3
$a_j \cdot (1+\pi) < y_i \leq a_{j+1}$ Zone B	$a_j \cdot (1+\pi) < y_i \cdot (1+\pi^0) \leq a_{j+1}$ Zone B	4
	$a_{j+1} < y_i \cdot (1+\pi^0) \leq a_{j+1} \cdot (1+\pi)$ Zone C	5

* Note that when the threshold of the first bracket is equal to zero, $\mathrm{a_0} = 0$, in that first bracket only taxpayers from categories 4 and 5 exist. Similarly, in the last bracket (k_i), only taxpayers from categories 1, 2, and 4 exist. The existence of taxpayers from all five categories is only feasible in the intermediate brackets of a tax schedule ($0 < \mathrm{j} < k_i$).

Table A.1 in the appendix displays, for each of these 5 categories, the taxes borne by $\pi^0 y_i$ under tax schedules ζ_0 and ζ_n^π along with the values of $\tau^{n,}_{\pi^0 y}(\vec{A})$ y $\tau^{n,}_{\pi^0 y}(\vec{A}^\pi)$. Based on this information, Table 2 reports the dynamic bracket creep for each category. Unlike ΔT_i^S, where all the brackets through which y_i passes influence its value, the magnitude of ΔT_i^D is affected by, at most, three brackets: the bracket in which y_i falls and its adjacent lower and upper brackets. It is noteworthy that $\Delta T_i^D > 0$ requires $\pi^0 \neq 0$. In other words, the dynamic component of bracket creep is not automatic but rather requires taxpayers to potentially offset, wholly or partially, the loss of purchasing power induced by inflation with increases in their personal incomes.

Table 2. Dynamic bracket creep based on taxpayer category.

Taxpayer category	dynamic bracket creep, ΔT_i^D, due to the absence of schedule indexation
Category 1	$(\tau_j - \tau_{j-1}) \cdot \pi^0 \cdot y_i$
Category 2	$(\tau_j - \tau_{j-1}) \cdot [a_j \cdot (1+\pi) - y_i]$
Category 3	$(\tau_j - \tau_{j-1}) \cdot [a_j \cdot (1+\pi) - y_i] + (\tau_{j+1} - \tau_j) \cdot [y_i \cdot (1+\pi^0) - a_{j+1}]$
Category 4	No bracket creep
Category 5	$(\tau_{j+1} - \tau_j) \cdot [y_i \cdot (1+\pi^0) - a_{j+1}]$

3.2 The bracket creep in the population aggregate

Building upon the preceding individual modeling, this subsection determines the total bracket creep generated by inflation in a finite population of taxpayers.

The aggregate static bracket creep

To analyze the aggregate effect of static bracket creep across an entire tax jurisdiction, consider a population of N taxpayers, each experiencing an individual static bracket creep of magnitude $\Delta T_1^S, \Delta T_2^S, \cdots, \Delta T_N^S$, with corresponding taxable incomes $y_1, y_2, \cdots, y_N$. The total taxable income in the jurisdiction is given by: $Y = \sum_1^N y_i$ and all taxpayers are subject to the initial tax schedule $\zeta_0 = \zeta(\vec{A}, \vec{\tau})$. Based on Equation [6], the total static bracket creep in the system is determined as follows:

$$\Delta T^S = \sum_{i=1}^{N} \sum_{j=0}^{K} \Delta T_i^{S^j}$$

Expanding this expression, we obtain:

$$\Delta T^S = \sum_{j=0}^{k}\{\pi_j \cdot (\tau_j - \tau_{j-1}) \cdot a_j \cdot [N_j^+ + (N_j - \tilde{N}_j)]\} + \sum_{j=0}^{k} \tilde{N}_j \cdot (\tau_j - \tau_{j-1}) \cdot (\tilde{y}_j^m - a_j) \quad [7]$$

where:

N_j = Number of taxpayers in bracket j.
$\tilde{N}_j$ = Number of taxpayers in bracket j, for whom $y_i < a_j \cdot (1+\pi)$.
N_j^+ = Number of taxpayers in brackets higher than j.
$\tilde{y}_j^m$ = Average taxable income in each bracket for taxpayers with $y_i < a_j \cdot (1+\pi)$

Equation [7] shows that the total static bracket creep in a tax jurisdiction is determined by the interaction between the tax schedule's structure—defined by marginal tax rates, bracket thresholds, and their inflation adjustments—and the distribution of taxpayers and taxable incomes across these brackets. The first summation on the right-hand side captures the cumulative effect of unindexed thresholds, encompassing both taxpayers in higher brackets (N_j^+) and those within bracket j whose taxable income surpasses $a_j \cdot (1+\pi)$, thereby subjecting them to increased taxation at higher marginal rates. The second summation captures the additional tax burden within each bracket j due to the failure to index tax thresholds, specifically for taxpayers whose taxable income remains below the inflated threshold, $a_j \cdot (1+\pi)$. Unlike the first summation, which focuses on taxpayers who cross into higher tax brackets, this term quantifies the bracket creep suffered by those who remain within their original bracket but still face an increased average tax rate.

Beyond computing the total static bracket creep for all taxpayers in a jurisdiction, it is essential to distinguish two additional measures: (i) the static bracket creep generated by each tax bracket, ΔT_j^S , and (ii) the total static bracket creep borne by all taxpayers within a given bracket, $\Delta T_{N_j}^s$. The first quantifies the excess tax burden produced by bracket j due to the lack of indexation. The second captures the total burden on taxpayers in bracket j, reflecting both its own bracket creep and the accumulated effect from preceding brackets. The contribution of each tax bracket j to the total static bracket creep is given by:

$$\Delta T_j^S = (\tau_j - \tau_{j-1}) \cdot \{(\tilde{y}_j^m - a_j) \cdot \tilde{N}_j + \pi_j \cdot a_j \cdot [(N_j - \tilde{N}_j) + N_j^+]\} \quad [8]$$

Equation [8] quantifies the bracket creep that originates specifically in bracket j, capturing two distinct effects. First, the *intra-bracket effect*, which affects taxpayers who remain within bracket j but experience a higher effective tax burden due to inflation, despite not crossing into a higher bracket. For these taxpayers, the individual tax increase is given by $(\tau_j - \tau_{j-1}) \cdot (\tilde{y}_j^m - a_j)$. Second, the *upper-bracket effect*, which applies to two groups of taxpayers: those whose taxable income passes through bracket j but ultimately falls into an upper bracket, and those who remain in bracket j but whose taxable income has been pushed beyond the original threshold due to inflation. In both cases, the lack of indexation results in exposure to higher marginal tax rates, thereby increasing their overall tax liability. For these taxpayers, the individual tax increase is given by $(\tau_j - \tau_{j-1}) \cdot \pi_j \cdot a_j$.

However, the total static bracket creep borne by all taxpayers within a given bracket j is not limited to the bracket creep generated within that bracket alone. Due to the cumulative nature of static bracket creep, taxpayers in bracket j are also affected by the bracket creep accumulated in all preceding brackets. The total static bracket creep borne by all taxpayers in bracket j, is given by:

$$\Delta T^{s}_{N_j} = \sum_{j=0}^{j-1}(\tau_i - \tau_{i-1}) \cdot \pi_i \cdot a_i \cdot N_j + (\tau_j - \tau_{j-1}) \cdot \{(\tilde{y}^{m}_{j} - a_j) \cdot \widetilde{N}_j + \pi_j \cdot a_j \cdot [(N_j - \widetilde{N}_j)]\} \quad [9]$$

Equations [8] and [9] establish a crucial distinction between these two measures of static bracket creep. The first, ΔT^{s}_{j}, captures the excess tax burden generated within a specific bracket due to the failure to adjust its threshold for inflation. This measure is confined to the bracket itself, reflecting only the impact of unindexed thresholds on taxable income within that range. In contrast, $\Delta T^{s}_{N_j}$ represents the total static bracket creep borne by all taxpayers in bracket j, incorporating both the direct burden from their own bracket and the cumulative effects of unindexed thresholds from preceding brackets. This distinction is essential for understanding the distributional impact of static bracket creep within a progressive PIT, as taxpayers in higher brackets not only face the tax increases associated with their own bracket but also inherit the accumulated effects of the tax structure below them.

The aggregate dynamic bracket creep

The total dynamic bracket creep in a tax jurisdiction can be computed by leveraging the classification of taxpayers into the five reference categories, based on their taxable income levels before and after inflation, y_i and $y_i \cdot (1 + \pi^0)$. Once each taxpayer's category is identified, the aggregate dynamic bracket creep is obtained by summing the individual bracket creep effects across all taxpayers in each category.

Formally, let n^{j}_{C} and Y^{j}_{C} denote, respectively, the number of taxpayers and the total taxable income within category C in bracket j, where $C = 1, 2, 3, 4, 5$ and $j = 0,1,2 \ldots, k$. The total dynamic bracket creep in the population, ΔT^{D}_{C}, is then given by the following expressions:

$$\Delta T^{D}_{1} = \sum_{j=0}^{k} (\tau_j - \tau_{j-1}) \cdot \pi^0 \cdot Y^{j}_{1}$$

$$\Delta T^{D}_{2} = \sum_{j=0}^{k} (\tau_j - \tau_{j-1}) \cdot [n^{j}_{2} \cdot a_j \cdot (1 + \pi) - Y^{j}_{2}]$$

$$\Delta T^{D}_{3} = \sum_{j=0}^{k} \{(\tau_j - \tau_{j-1}) \cdot [n^{j}_{3} \cdot a_j \cdot (1 + \pi) - Y^{j}_{3}] + (\tau_{j+1} - \tau_j) \cdot [Y^{j}_{3} \cdot (1 + \pi^0) - n^{j}_{3} \cdot a_{j+1}]\} \quad [10]$$

$$\Delta T^{D}_{4} = 0$$

$$\Delta T_5^D = \sum_{j=0}^{k} (\tau_{j+1} - \tau_j) \cdot [Y_5^j \cdot (1 + \pi^0) - n_5^j \cdot a_{j+1}]$$

These expressions reflect how each taxpayer category contributes to the total dynamic bracket creep:

- Category 1 includes taxpayers whose income increase is fully taxed within the same bracket, leading to a direct tax increase proportional to $\pi^0 \cdot Y_1^j$.
- Category 2 comprises individuals whose post-inflation taxable income remains below the indexed threshold, but who still experience a tax increase due to their relative position within the bracket.
- Category 3 consists of taxpayers who partially exceed their initial bracket due to inflation, facing a tax increase in both their original and the next bracket.
- Category 4 represents taxpayers who remain in the same bracket without experiencing any additional tax burden, resulting in zero dynamic bracket creep.
- Category 5 includes taxpayers who fully cross into a higher bracket, incurring additional taxation under the new marginal rate.

Summing across all five categories yields the total dynamic bracket creep in the population:

$$\Delta T^D = \sum_{C=1}^{5} \Delta T_C^D$$

Substituting from the category-specific expressions, the total dynamic bracket creep affecting the jurisdiction can be rewritten as:

$$\Delta T^D = \sum_{j=0}^{k} \{ (\tau_j - \tau_{j-1}) \cdot \pi^0 \cdot Y_1^j + (\tau_j - \tau_{j-1}) \cdot [n_2^j \cdot a_j \cdot (1 + \pi) - Y_2^j] + (\tau_j - \tau_{j-1}) \cdot [n_3^j \cdot a_j \cdot (1 + \pi) - Y_3^j] + (\tau_{j+1} - \tau_j) \cdot [Y_3^j \cdot (1 + \pi^0) - n_3^j \cdot a_{j+1}] + (\tau_{j+1} - \tau_j) \cdot [Y_4^j \cdot (1 + \pi^0) - n_4^j \cdot a_{j+1}] \} \quad [11]$$

The aggregate total bracket creep

Consequently, combining Equations [10] and [11], the total bracket creep in a jurisdiction with N tax units is given by:

$$\Delta T = \Delta T^S + \Delta T^D \quad [12]$$

which captures the combined effect of static and dynamic bracket creep, quantifying the additional tax burden resulting from unindexed thresholds in the PIT schedule across the taxpayer population. These formulae apply specifically to the standard case of graduated tax schedules, where tax rates increase in discrete steps based on predefined income brackets. This step-wise structure, the focus of this analysis, is by far the most prevalent design in personal income taxation worldwide.[6]

4. AN EMPIRICAL APPLICATION: EXPLORING BRACKET CREEP IN SPAIN (2021-2022)

As demonstrated, inflation not only erodes the purchasing power of the population at large but also imposes an additional burden on those who are net contributors to income taxation. Between January 2021 and December 2022, Spain experienced a cumulative inflation rate of 12.57%—6.5% in 2021 and 5.7% in 2022. However, the government chose not to index the tax schedules under its jurisdiction. As a result, Spanish taxpayers faced a dual impact: a decline in real income and an increase in both their average and marginal tax burdens. In the following section, we apply the model developed above to quantify this inflation-induced tax burden.[7]

4.1 Specificities of the Spanish Personal Income Tax (IRPF) and Data Used

The Spanish Personal Income Tax (IRPF) is a dual tax where savings income (saving taxable income) is taxed separately from other income (general taxable income). IRPF applies four different tax schedules as each income type faces two tax schedules, one at the national level and another at the regional level. Additionally, IRPF is partially devolved to regional governments (Autonomous Communities), though their authority is limited to setting the regional general tax schedule. The remaining three schedules—the national general tax schedule and both savings income schedules—fall under the exclusive jurisdiction of the central government.

Next, we analyze the bracket creep resulting from the non-indexation of the three tax schedules under the jurisdiction of the central government: the national tax schedule for general

[6] In contrast, preventing bracket creep in a continuously defined income tax, such as Germany's, requires a more complex adjustment process. Unlike stepwise progressive systems, where inflation adjustments can be made by simply shifting tax brackets upward, smoothly progressive systems demand a more nuanced approach. First, all income thresholds must be indexed to inflation to prevent taxpayers from moving into higher marginal tax rates due solely to nominal income growth. Second, the parameters of the quadratic functions governing lower and intermediate brackets must be adjusted proportionally to maintain the smooth progression of marginal rates, ensuring continuity and differentiability at transition points. Finally, for upper income brackets, where taxation is typically linear, adjustments should preserve the seamless transition from the last progressive segment to the fixed marginal rate. Without these modifications, indexing only the thresholds in the German income tax would distort the overall distribution of the tax burden.

[7] Note that the total cost associated with the absence of tax indexing will exceed the amounts reported here. Full indexing of the Personal Income Tax (PIT) requires that, in addition to the tax schedule, other critical tax parameters such as fixed deductions, allowances and tax credits operating in the taxable income or in the tax liability are also indexed. These "other" elements can generate a surtax greater than that generated by the tax schedule(s) themselves.

taxable income and the two tax schedules for savings income. The findings presented below are based on the application of the model developed earlier to microdata from 2019, provided by the State Tax Administration Agency (AEAT) and the Institute of Fiscal Studies (IEF). The dataset consists of 3,315,632 tax returns, carefully selected to be representative of a total population of 21,028,886 tax returns.[8]

4.2 Non-indexation of State tax schedules.

The initial step in neutralizing the effects of inflation on the Personal Income Tax (IRPF) schedule is determining the appropriate indexation rate. In this respect, it seems reasonable to assume that inflation levels considered consistent with price stability should not be subject to indexation. In the European Union (EU), the European Central Bank (ECB) defines price stability as an inflation rate of approximately 2%. Consequently, the indexation percentage applied will exclude this 2% from the overall inflation rate, ensuring that only excess inflation is corrected. Second, while inflation erodes the purchasing power of gross household income, the relevant income measure for bracket creep is taxable income, as it is the basis upon which the tax schedule applies. Given that the legal definition of taxable income ensures that changes in gross income do not translate into taxable income on a one-to-one basis, the indexation rate, π^0, must account for this distinction. A reasonable way to capture this adjustment is through the elasticity of taxable income with respect to gross income, η_{ti,x_b}, which measures the percentage change in taxable income for a 1% change in gross income. In the Spanish IRPF, this elasticity is approximately 0.95 (Arrazola et al., 2019).

Armed with these two considerations, a reasonable indexing rate for Spain in 2022 would amount to 8.4%. Therefore, we will assume $\pi_j = 0.084 \ \forall \, j \in [0, k]$. As for dynamic bracket creep, we will assume $\pi^0 = 0{,}038$, equivalent to 95% of the increase in national wage costs between 2020 and 2022, according to the Quarterly Labor Cost Survey conducted by the National Institute of Statistics (INE). These values of π_j and π^0 will be applied to both the general tax schedule and the savings tax schedules.

[8] The sample size was calculated to achieve an error margin of less than 1.5% in the mean of the income variable, with a confidence level of 0.3%. A random stratified sampling method was employed in the sample selection, considering three levels of stratification: province (comprising the 46 provinces of the common fiscal territory, along with the autonomous cities of Ceuta and Melilla), income level (12 brackets), and type of declaration (individual or joint). Thus, the number of strata in the sampling process amounted to 1,764 (9x12x2), with no empty strata.

4.2.1. The static bracket creep

Table 3 presents the structure of marginal rates and thresholds of the general state tax schedule in 2022, ζ_0, along with the population distribution of the various types of taxpayers across its brackets.

Table 3. Thresholds, marginal tax rates, and taxpayer distribution in the state tax schedule for the general taxable income 2022, ζ_0.

Bracket j	a_j	τ_j	N_j	N_j^+	$\tilde{N}_j$	$\tilde{y}_j^m$	$(N_j - \tilde{N}_j)$
Bracket 0	0	0.095	8,843,950	12,182,098	-		8,843,950
Bracket 1	12450	0.12	3,949,104	8,232,994	448,484	13,018	3,500,619
Bracket 2	20200	0.15	5,249,127	2,983,867	945,148	21,108	4,303,979
Bracket 3	35200	0.185	2,273,058	710,810	746,535	36,534	1,526,523
Bracket 4	60000	0.225	693,814	16,995	142,560	62,597	551,254
Bracket 5	300000	0.245	16,995	-	2,580	313,178	14,415

Note: a_j = income threshold; τ_j= marginal tax rate; N_j= Number of taxpayers in bracket j; N_j^+= Number of taxpayers in brackets higher than j; $\tilde{N}_j$= Number of taxpayers in bracket j, for whom $y_i < a_j \cdot (1 + \pi)$; $\tilde{y}_j^m$= Average taxable income in bracket for taxpayers with $y_i < a_j \cdot (1 + \pi)$.

Figure 2 compares the marginal and average tax rates of the tax schedule with and without indexing. As can be observed, the absence of indexing in 2022 results in an implicit increase in both average and marginal tax rates, although the patterns of increase differ. The increase in marginal tax rates occurs only in the ranges of the taxable income near the lower and upper thresholds of each bracket. In contrast, the rise in the average tax rate, on the other hand, is generalized throughout the entire distribution of the taxable income, affecting virtually all taxpayers with a positive tax liability. This difference in the pattern of increase is due to the cumulative nature of the static bracket creep, which causes the average tax rate to accumulate the increases in tax liability generated by all the brackets through which the taxable income passes. This increase in average tax rates, caused by the accumulated increase in marginal tax rates, is the ultimate driver of the revenue gains induced by bracket creep.

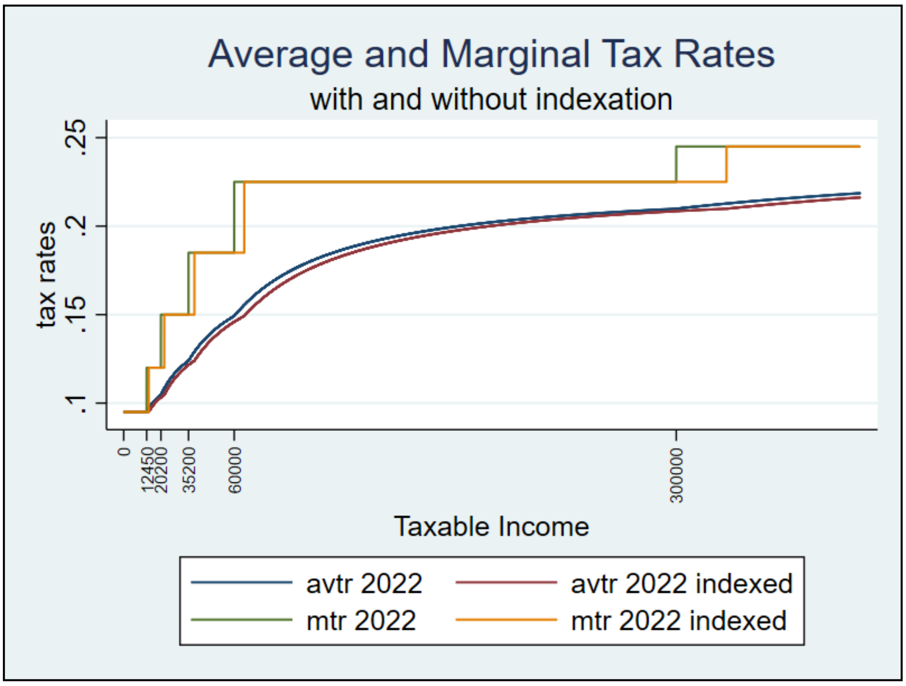

Figure 2: Average and marginal tax rates derived from the Central Government tax schedule (2022), with and without indexing.

As elucidated during the derivation of expressions [6] and [7], not indexing a bracket signifies that the taxable income passing through that bracket will bear an additional tax burden. This burden depends on whether $y_i \geq a_j(1+\pi)$ or if $a_j < y_i < a_j(1+\pi)$. Table 4 outlines the static bracket creep generated in each tax bracket, both individually and cumulatively. The initial two columns display the values if $y_i \geq a_j(1+\pi)$, while columns 3 and 4 present the same values when $a_j < y_i < a_j(1+\pi)$.

Figure 3 graphically presents the information contained in Table 4. As can be observed, static bracket creep increases with the bracket ranking (individual), and due to the drag effect from lower to upper brackets, the penalty is cumulative and rises with the magnitude of the taxable income (accumulated). Namely, static bracket creep penalises wealthier taxpayers more severely. For instance, in the case at hand, while taxpayers in the 0 bracket do not suffer static bracket creep at all, taxpayers in the last bracket bear a surtax reaching € 886.14 if $y_i \geq a_j(1+\pi)$ or € 422.35 if $a_j < y_i < a_j(1+\pi)$.

Table 4. Static bracket creep, individual and accumulated, within each bracket depending on the position of the taxpayer's taxable income.				
Bracket j	$y_i \geq a_j(1+\pi)$		$a_j < y_i < a_j(1+\pi)^*$	
	$a_j\pi(\tau_j - \tau_{j-1})$	$\sum_{j=0}^{k_i} a_j\pi(\tau_j - \tau_{j-1})$	$(y_i - a_{k_i})(\tau_j - \tau_{j-1})$	$\sum_{j=0}^{k_i-1}[a_j\pi(\tau_j - \tau_{j-1})] + (y_i - a_{k_i})(\tau_{k_i} - \tau_{k_i-1})$
0	-	-	-	-
1	26.15	26.15	13.18	13.18
2	50.90	77.05	25.27	38.45
3	103.49	180.54	43.51	81.96
4	201.60	382.14	96.39	178.35
5	504.00	886.14	244.00	422.35

* The tabulated value for this type of taxpayer assumes $y_i = \tilde{y}_j^m$

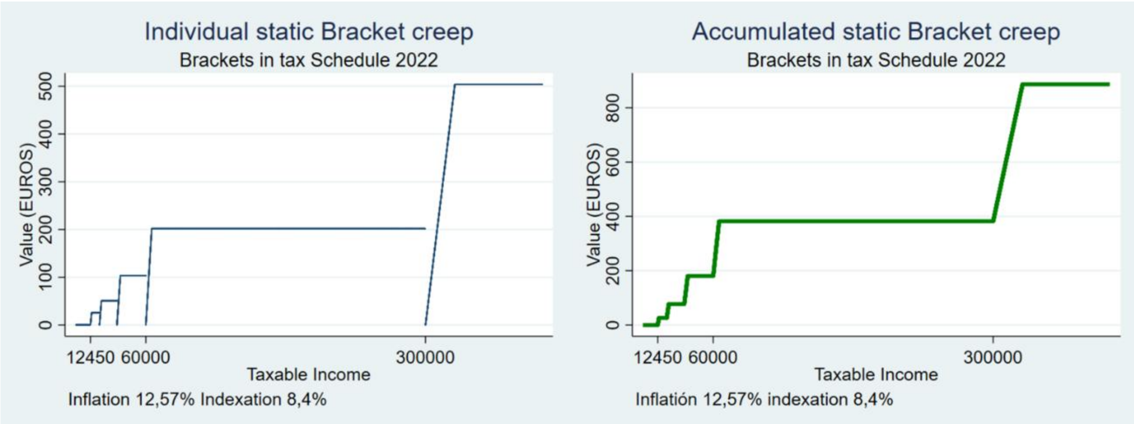

Figure 3: Static bracket creep generated individually and in accumulation in each bracket in the Central Government tax schedule (2022).

Based on the information from Table 4 and the distribution of taxpayers from Table 3, the computation of expression [8] allows for the determination of the aggregate bracket creep and its distribution by brackets. Table 5 displays this information. The first column illustrates the static bracket creep attributed to taxpayers whose taxable income falls into brackets higher than j, despite passing through bracket j (N_j^+). Columns 2, 3, and 4 show the bracket creep effectively borne by taxpayers falling into bracket j, discriminating between taxpayers with taxable incomes exceeding $a_j \cdot (1+\pi)$ and those that do not exceed that amount ($\tilde{N}_j$). Column 4 represents the sum of columns 2 and 3 and, therefore, captures the total amount of static bracket creep borne by taxpayers in bracket (N_j). Column 5 captures the total bracket creep generated by each bracket, both by those falling into the bracket (N_j) and by those in higher brackets (N_j^+).

Table 5. Aggregate static bracket creep and its distribution across brackets					
	Cost for taxpayers above bracket j.	Cost for taxpayers whose income falls within bracket j			Total cost generated by bracket j
Bracket j	$\pi \cdot (\tau_j - \tau_{j-1}) \cdot a_j \cdot N_j^+$	$\pi \cdot (\tau_j - \tau_{j-1}) \cdot a_j \cdot (N_j - \tilde{N}_j)$	$\tilde{N}_j \cdot (\tau_j - \tau_{j-1}) \cdot (\tilde{y}_j^m - a_j)$	Total cost borne by N_j	Total cost borne by N_j and N_j^+
Bracket 0	-	-	-	-	-
Bracket 1	215,251,641	92,382,971	5,477,124	97,860,095	313,111,736
Bracket 2	151,890,779	222,523,502	22,177,214	244,700,716	396,591,495
Bracket 3	73,560,279	161,829,690	30,863,255	192,692,945	266,253,224
Bracket 4	3,426,274	113,032,487	12,833,541	125,866,028	129,292,303
Bracket 5	-	7,355,442	585,922	7,941,364	7,941,364
Total	**444,128,973**	597,124,092	71,937,056	**669,061,148**	**1,113,190,122**

The analysis of Table 5 reveals several noteworthy findings [9]:

- The non-indexation of the state tax schedule (general taxable income) results in a static bracket creep of over 1,113 million euros.
- The distribution of the static bracket creep across the tax bands exhibits non-uniform patterns. For instance, while the non-indexation of Bracket 0 does not contribute to bracket creep, the non-indexation of Bracket 2 accounts for 35.63% of the total bracket creep (more than 396 million), and the non-indexation of Bracket 5 contributes to merely 0.71% (7.9 million).[10]
- Not indexing a bracket results in a static bracket creep borne by all taxpayers either falling into that bracket or passing through it. In other words, a portion of the static bracket creep is transferred to taxpayers positioned higher up in the tax schedule, as reported in columns 1 and 4. Note that out of the total 1,113 million euros of generated bracket creep, 60.10% (669,061,148 euros) is borne by taxpayers within the bracket and 39.9% (444,128,973 euros) by taxpayers situated in higher brackets.

The breakdown of the distribution of static bracket creep transferred to higher brackets is presented in Table 6. For illustrative purposes, focusing on the distribution of the 215 million euros transferred from Bracket 1 upwards, over 137 million euros are borne by taxpayers in Bracket 2, 59 million euros by those in Bracket 3, 18 million euros by those in Bracket 4, and 444 thousand euros by taxpayers in the last bracket. The interpretation of the remaining columns in Table 6 follows a similar pattern.

[9] These results require an adjustment to take into account the peculiarities of the non-genuine personal and family allowances, characteristic of Spanish personal income tax. See Appendix 2.

[10] This distribution of the total bracket creep by income brackets is due to the smaller number of taxpayers in the higher brackets of the tax schedule. It is worth noting that individual static bracket creep increases with the ranking of the bracket and is also cumulative, resulting in wealthier taxpayers individually experiencing a higher inflationary tax burden. Specifically, referring to Table 4, while taxpayers in the lowest bracket do not experience a tax surplus at all, those in the highest bracket incur a tax surplus amounting to € 886.14 if $y_i \geq a_j(1+\pi)$ or € 422.35 if $a_j < y_i < a_j(1+\pi)$.

Tabla 6. Distribution among higher brackets of the cost resulting from the non-indexation of each bracket					
Cost transferred to	Non-indexation bracket 0	Non-indexation bracket 1	Non-indexation bracket 2	Non-indexation bracket 3	Non-indexation bracket 4
Bracket 1	.				
Bracket 2	.	137,238,431			
Bracket 3	.	59,429,089	115,707,720		
Bracket 4	.	18,139,776	35,317,925	71,801,458	
Bracket 5	.	444,345	865,134	1,758,821	3,426,274
	Total, per bracket	**215,251,641**	**151,890,779**	**73,560,279**	**3,426,274**
	Total, tax schedule	**444,128,973**			

The static bracket creep of the remaining tax schedules: aggregate computation

As previously indicated, the Spanish IRPF exhibits a dual structure whereby savings incomes are taxed separately from other incomes. Specifically, savings incomes in Spain are subject to two tax schedules: one at the national level and another at the regional level. The design and structure of these rate schedules fall under the exclusive jurisdiction of the central government, which has chosen not to index them. Consequently, it is necessary to quantify the bracket creep generated by these schedules.

Although we could replicate the detailed analysis conducted for the general taxable income, in this subsection, we will limit ourselves to quantifying the aggregate static bracket creep generated on savings incomes. Table 7 presents the net static bracket creep (adjusted for effect on non-genuine thresholds mentioned in Appendix 2) resulting from the non-indexation of the three rate schedules for which the State has competencies. As shown, the non-indexation will lead to a static bracket creep in 2022, amounting to €1,113,672,125.

Table 7. Static bracket creep due to non-indexation of State tax schedules on general taxable income and savings taxable income (2022)				
Schedule for general taxable income		**Schedule for savings taxable income**		**Static bracket creep (Total)**
Bracket creep general taxable income	Gains in tax savings from personal a family allowances	Bracket creep savings taxable income	Gains in tax savings from personal a family allowances	
1,113,190,122	**21,632,430**	**23,786,257**	**1,672,037**	**1,113,672,125**

4.2.2. The dynamic bracket creep

As previously justified at the outset of this section, the computation of dynamic bracket creep assumes π^0=0.038 for both the general taxable income and the taxable income on savings. Table 8 provides the additional nominal tax collected resulting from this increase in taxable incomes. As evident, the expansion of taxable bases will lead taxpayers to incur an additional tax burden of nearly 3.000 billion euros (2,925,065,537 €), with 82.3% stemming from the taxation of the general taxable income (2,583,520,606 €), and the remainder from the taxation of savings taxable incomes (341,544,931 €).

Table 8. Additional nominal tax collected by the Personal Income Tax (IRPF) due to the increase in taxable income induced by inflation.

General income tax schedule	Savings tax schedule	Total nominal tax
2,583,520,606	**341,544,931**	**2,925,065,537**

However, this nearly €3 billion in nominal tax does not align with the dynamic bracket creep generated by inflation. To ascertain this dynamic component of bracket creep, it is necessary to determine the varying tax rates that would be applied both with and without schedule indexing. As previously discussed, the model addresses this question by categorizing taxpayers into five categories, enabling the identification of the portion of the nominal tax that genuinely corresponds to the generated dynamic bracket creep. Table 9 presents the dynamic bracket creep generated by the general taxable income and savings. As observed, the dynamic component of the bracket creep amounts to €74,294,263, a significantly lower figure compared to the static bracket creep (€1,113,672,125). It is surprising, therefore, that despite bracket creep being essentially a static phenomenon, its definition continues to be based on its dynamic component.

Table 9. Dynamic bracket creep due to non-indexation of tax schedules (2022)

General income tax schedule	Savings tax schedule	Dynamic bracket creep
73,337,364	**956,899**	**74,294,263**

Finally, Table 10 provides supplementary information regarding the dynamic bracket creep generated by both the general taxable income and savings. Specifically, they present the classification of taxpayers by categories, as well as the nature of the "jumps" in tax brackets that occur due to the absence of schedule indexing. The figures confirm that the vast majority of taxpayers belong to category 4, which precisely corresponds to the category that does not incur a dynamic burden.[11] That is to say, for the vast majority of taxpayers, the compensatory increase in income they receive to alleviate the loss of purchasing power caused by inflation does not induce dynamic bracket creep (although it does static). On the

[11] As depicted in Table 2 of the main text, Category 4 corresponds to taxpayers for whom the taxable incomes, y_i, and $y_i \cdot (1+\pi^0)$ are bounded within the following intervals:

- $y_i < a_j \cdot (1+\pi_j) \wedge y_i < a_{j+1}$
- $a_j \cdot (1+\pi_j) < y_i \cdot (1+\pi^0) \leq a_{j+1}$

other hand, concerning the nature of the bracket jumps, the majority occur not at the upper end of the bracket but at the lower end.

Table 10. Distribution of Tax Returns by Category and number and nature of jumps caused by the non-indexation of the tax schedule					
	Number of tax returns in each category				
	Category 1	Category 2	Category 3	Category 4	Category 5
General Tax schedule	1,219,637	918,501	-	16,100,135	908,264
Savings Tax schedules	22,651	17,543	-	10,198,016	19,485
	Total number of tax returns where bracket jumps occur				
	Jumps at the upper threshold		Jumps at the lower threshold		
General Tax schedule	908,264		2,138,138		
Savings Tax schedules	19,485		40,194		

While the preceding analysis has applied the model to the entirety of the Spanish tax jurisdiction, its flexibility allows for more granular examinations at smaller geographical scales, provided sufficiently detailed microdata are available. To illustrate this, Appendix III presents key results—encompassing both static and dynamic bracket creep—disaggregated by Spain's 15 Autonomous Communities (regions) and two Autonomous Cities, showing how the magnitude of bracket creep is regionally shaped by the size and distribution of taxable income and taxpayers across the tax schedule brackets.

4.3 Distributive impact

As illustrated in Figure 2 and Table 4, the absence of indexing alters the average and marginal tax rates, thereby inevitably affecting the structural and effective progressivity of the tax. This alteration in progressivity, coupled with the analyzed revenue shift, will modify the redistributive capacity of the tax.

This section presents the distributive consequences of the absence of schedule indexing. To this end, we analyze the impact of indexing the tax schedule on Musgrave and Thin's local progressivity measures set out in their pioneering paper of 1948 –average rate progression (arp), liability progression (lp), and the progression of residual income (rp). The impact on effective progressivity is assessed through the dominance analysis of concentration curves of tax liabilities and the Kakwani index (1976, 1977). The effect on the redistributive power of the tax is measured through the Reynolds-Smolensky index (1977).

Figure 4 displays the local progressivity measures with and without indexing. As can be observed, indexing the tax schedule entails shifting the tax progressivity profile rightward. Specifically, indexing reduces progressivity in the vicinity of the lower threshold of the brackets, although it increases it in the rest of the bracket until transitioning to the next one. As illustrated in Figure 3, this pattern is repeated across all three analyzed local progression measures. Moreover, it is worth noting that this alteration of the local progressivity of the tax schedule stems exclusively from the static component of the bracket creep, not from the dynamic one.

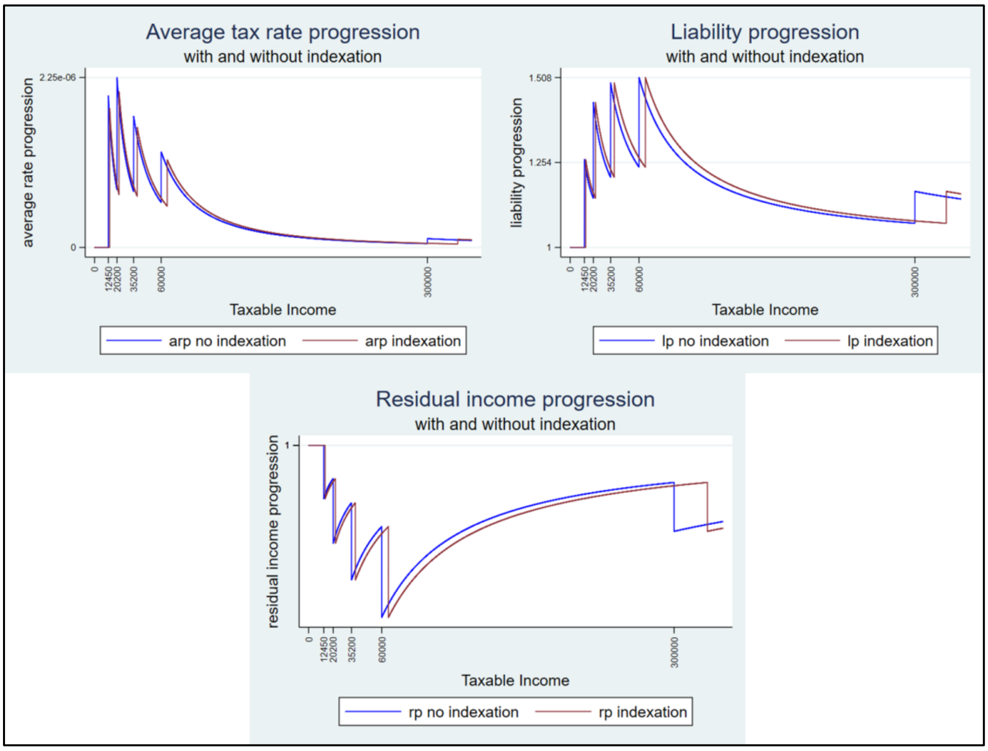

Figure 4: Evolution of the local progressivity of the tax schedule under scrutiny, with and without indexing.

This unequal impact on the structural progressivity of the tax schedule suggests that the effect on the effective progressivity of the tax will depend on how taxable income is distributed across and within brackets. Specifically, the computation of the concentration curves of tax liabilities with and without indexing —denoted as $L^{C}_{T\_indexed}$ and $L^{C}_{T\_nonindexed}$, respectively — confirms that $L^{C}_{T\_indexed}$ intersects from above with $L^{C}_{T\_nonindexed}$ indicating the absence of dominance in either direction.[12] Given the lack of clear dominance in concentration curves to confirm greater effective progressivity in the presence or absence of indexing, Table 11 presents the values of some substitute indices for the most robust dominance criteria of concentration curves. These values confirm that not indexing the tax schedule leads to a slight increase in the Kakwani index as well as an augmentation of the redistributive power of the tax captured by the Reynolds-Smolensky index. However, the magnitude of the reduction in post-tax income inequality captured by the Gini index is negligible.[13] These results are consistent with those obtained by Immervoll (2005) and Levy et al. (2010), which also find that non-indexation enhances redistribution, although in their case, it leads to a decrease in the progressivity of the tax.

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[12] The cross between concentration curves occurs in the upper part of the distribution, specifically at population observation 19,504,410. Concentration curves have not been drawn because the difference in value between the ordinates of both curves occurs from the fifth or sixth decimal place, making graphical visualization of dominance impossible.

[13] Following Subramanian (2002), not indexing the tax schedule would mean that the proportion of income retained by the poorest taxpayer in a two-individual world would increase from 27.41% to 27.44%. In other words, indexing the tax schedule would increase inequality to a negligible extent.

Table 11. Main distributive indices linked to the indexation of the State tax schedule on General Taxable Income (2022)	
Indices	**Value**
Gini taxable income	0.46383467
Gini after-tax income without indexation	0.4512762
Gini after-tax income with indexation	0.45185243
Kakwani without indexation	0.08599198
Kakwani with indexation	0.08405509
Reynolds-Smolensky without indexation	0.01255847
Reynolds-Smolensky with indexation	0.01198223
Average tax rate without indexation	0.17083156
Average tax rate with indexing	0.16750486

5. INSIGHTS AND CONCLUDING REMARKS

In this paper, we delve into the mathematical modeling of bracket creep arising from the absence of schedule indexing in inflationary contexts. Our model reveals the presence of two distinct components within bracket creep: a static component, which emerges automatically due to inflation, and a dynamic component, associated with the customary nominal income increases observed in inflationary environments to counteract the loss of purchasing power caused by rising prices. Notably, the static component outweighs the dynamic one both conceptually and quantitatively. This underscores an important point: bracket creep does not necessarily hinge on an increase in taxpayers' incomes; it occurs automatically, even if their income remains constant or if there's a reduction in the taxable base. Despite its significant impact, it is remarkable that public discourse tends to focus solely on the dynamic component, overlooking the substantial implications of the static component, which, as our model demonstrates, poses the greatest financial burden on taxpayers while being the most lucrative for revenue collection by the government. The model has been developed both for the individual taxpayer and for the population as a whole. To illustrate its practical utility, we apply it to recent developments in Spain.

The findings from this empirical analysis demonstrate that the decision not to index the tax schedule has imposed an additional tax of over 1,187 million euros on Spanish taxpayers, of which 94% (1,114 million) corresponds to static bracket creep and the remainder (74 million) to the dynamic component. This is primarily because the absence of indexing increases the aggregate marginal tax rate by 0.37 percentage points and the average tax rate by 0.33 percentage points. On the other hand, it is confirmed that the distributive impact of the decision not to index the tax schedule is negligible. However, non-indexation increases local progressivity in the vicinity of the lower threshold of the bracket and reduces it in the rest of the bracket. In terms of global progressivity, the results are inconclusive, although the values of Kakwani and Reynolds-Smolensky indices indicate that progressivity and redistribution would increase slightly if the tax schedules were not indexed.

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APPENDICES

Appendix 1

Table A.1.1. Marginal tax rates borne by $\pi^0 y_i$ depending on the location of y_i and $y_i(1+\pi^0)$ in the critical zones arising from the indexation of bracket k_i.

Location of the original taxable base y_i		Tax on inflated taxable income according to its magnitude and position $y_i \cdot (1+\pi^0)$		Marginal tax rates with and without schedule indexation	
		ζ_0	ζ_n^{π}	$\tau^{n,}_{\pi^0 y}(\vec{A})$	$\tau^{n,}_{\pi^0 y}(\vec{A}^{\pi})$
$a_j < y_i \le a_{j+1}$	$a_j < y_i \le a_j \cdot (1+\pi)$	$y_i \cdot (1+\pi^0) \le a_j \cdot (1+\pi)$			
		$\tau_j \cdot \pi^0 \cdot y_i$	$\tau_{j-1} \cdot \pi^0 \cdot y_i$	τ_j	τ_{j-1}
		$a_j \cdot (1+\pi) < y_i \cdot (1+\pi^0) \le a_{j+1}$			
		$\tau_j \cdot [a_j \cdot (1+\pi) - y_i]$ $+\tau_j \cdot [y_i \cdot (1+\pi^0) - a_j \cdot (1+\pi)]$	$\tau_{j-1} \cdot [a_j \cdot (1+\pi) - y_i]$ $+\tau_j \cdot [y_i \cdot (1+\pi^0) - a_j \cdot (1+\pi)]$	τ_j	$\frac{[a_j \cdot (1+\pi) - y_i]}{\pi^0 \cdot y_i} \cdot \tau_{j-1} + \frac{[y_i \cdot (1+\pi^0) - a_j \cdot (1+\pi)]}{\pi^0 \cdot y_i} \cdot \tau_j$
		$a_{j+1} < y_i \cdot (1+\pi^0) \le a_{j+1} \cdot (1+\pi)$			
		$\tau_j \cdot [a_j \cdot (1+\pi) - y_i]$ $+\tau_j \cdot [a_{j+1} - a_j]$ $+\tau_{j+1} \cdot [y_i \cdot (1+\pi^0) - a_{j+1}]$	$\tau_{j-1} \cdot [a_j \cdot (1+\pi) - y_i]$ $+\tau_j \cdot [a_{j+1} - a_j]$ $+\tau_j \cdot [y_i \cdot (1+\pi^0) - a_{j+1}]$	$\frac{[a_j \cdot (1+\pi) - y_i + (a_{j+1} - a_j)]}{\pi^0 \cdot y_i} \cdot \tau_j + \frac{[y_i \cdot (1+\pi^0) - a_{j+1}]}{\pi^0 \cdot y_i} \cdot \tau_{j+1}$	$\frac{[a_j \cdot (1+\pi) - y_i]}{\pi^0 \cdot y_i} \cdot \tau_{j-1} + \frac{[y_i \cdot (1+\pi^0) - a_j]}{\pi^0 \cdot y_i} \cdot \tau_j$
	$a_j \cdot (1+\pi) > y_i \le a_{j+1}$	$a_j \cdot (1+\pi) < y_i \cdot (1+\pi^0) \le a_{j+1}$			
		$\tau_j \cdot \pi^0 \cdot y_i$	$\tau_j \cdot \pi^0 \cdot y_i$	τ_j	τ_j
		$a_{j+1} < y_i \cdot (1+\pi^0) \le a_{j+1} \cdot (1+\pi)$			
		$\tau_j \cdot (a_{j+1} - y_i)$ $+\tau_{j+1} \cdot [y_i \cdot (1+\pi^0) - a_{j+1}]$	$\tau_j \cdot (a_{j+1} - y_i)$ $+\tau_j \cdot [y_i \cdot (1+\pi^0) - a_{j+1}]$	$\frac{(a_{j+1} - y_i)}{\pi^0 \cdot y_i} \cdot \tau_j + \frac{[y_i \cdot (1+\pi^0) - a_{j+1}]}{\pi^0 \cdot y_i} \cdot \tau_{j+1}$	τ_j

Appendix 2

The anomaly in the design of the Spanish personal income tax since 2007: Non-genuine personal and family allowance

In Spain, non-genuine personal and family allowances are applied. This peculiarity requires us to also evaluate the impact of the absence of indexation of the schedule on the value of the tax savings generated by these false allowances.

Since the enactment of Law 35/2006, the Spanish Personal Income Tax (IRPF) has designated certain amounts as "personal and family allowances", despite the fact that they do not function as true allowances, as they do not reduce taxable income. This misclassification conceptually distorts the fundamental notion of a basic allowance, which should represent the minimum income necessary for a taxpayer and their family to sustain a basic standard of living and, therefore, should remain untaxed. In reality, what are referred to as "personal and family allowances" in Spain are actually non-refundable tax credits deducted directly from the taxpayer's final tax liability. Their value is determined by applying the tax schedule separately to the total amount of allowances to which a taxpayer is entitled. As a result, adjustments to the tax schedule—whether through indexation or non-indexation—affect not only the total tax burden associated with taxable income but also the tax relief provided by these "allowances". Specifically, indexing the tax schedule decreases the value of the tax savings derived from these credits, while failing to adjust for inflation increases them. However, the magnitude of this effect is generally small since, for most taxpayers, personal and family allowances fall within the first tax bracket and are therefore calculated at the lowest marginal rate.

Table A.2.1. provides clear evidence of this phenomenon. As depicted, nearly 97% of the tax returns filed in 2022 report allowances below €12,450, with only 3.01% transitioning to the second bracket and a mere 0.43% advancing to the third; the number of returns with allowances reaching higher brackets is negligible.

Tabla A.2.1. Distribution of tax returns by brackets according to where personal and family allowances fall (2022)

Bracket	Allowance range	Tax returns with allowances falling within the bracket	Percentage of total tax returns
0	0-12450	20,302,467	96.56%
1	12450-20200	632,402	3.01%
2	20200 - 35200	90,343	0.43%
3	35200 - 60000	833	0.004%
4	60000-300000	3	0.00002%
5	>300000	-	0

Table A.2.2. reports the loss of tax savings resulting from personal and family allowances. As illustrated, the loss of tax savings amounts to € 21,632,430, resulting in the net cost of not adjusting the state's general tax rate to be € 1,091,557,692 (€ 1,113,190,122 - € 21,632,430).

Table A.2.2. Reduction in Tax Savings Due to Schedule Indexation of Non-Genuine Allowances in Spain					
	Loss for taxpayers in brackets above bracket j	Loss for taxpayers in bracket j			Total loss generated by bracket j
Bracket	$\pi \cdot (\tau_j - \tau_{j-1}) \cdot a_j \cdot N_j^+$	$\pi \cdot (\tau_j - \tau_{j-1}) \cdot a_j \cdot (N_j - \tilde{N}_j)$	$\tilde{N}_j \cdot (\tau_j - \tau_{j-1}) \cdot (\tilde{M}_j^m - a_j)$	Total loss borne by N_j	Total loss borne by N_j y N_j^+
0	-	-	-	-	-
1	2,383,892	13,053,958	2,194,433	15,248,392	17,632,284
2	42,571	3,227,250	673,624	3,900,874	3,943,445
3	362	32,190	23,841	56,032	56,393
4	-	211	97	308	308
5	-	-		-	-
Total					**21,632,430**

Appendix 3

Table A.3.1. Territorial distribution of the static bracket creep due to non-indexation of State tax schedules on general taxable income and savings taxable income (2022)					
AUTONOMOUS COMMUNITY	**Schedule for general taxable income**		**Schedule for savings taxable income**		**Static bracket creep by Region (Total)**
	Bracket creep general taxable income	Gains in tax savings from personal a family allowance	Bracket creep savings taxable income	Gains in tax savings from personal a family allowance	
Andalusia	147,157,623	3,507,186	2,507,983	253,898	145,904,523
Aragon	36,057,989	681,348	618,920	67,394	35,928,167
Principality of Asturias	27,232,758	742,349	372,725	48,881	26,814,253
Balearic Islands	30,266,841	397,022	1,071,133	35,598	30,905,353
Canary Islands	40,072,696	839,043	834,292	49,951	40,017,993
Cantabria	14,762,622	383,733	270,865	32,931	14,616,824
Castile and León	56,846,752	1,295,334	805,021	127,635	56,228,804
Castile-La Mancha	37,759,962	999,722	512,066	72,083	37,200,223
Catalonia	243,123,014	4,330,027	5,645,747	340,353	244,098,381
Valencian Community	105,509,866	2,086,511	2,277,034	190,247	105,510,142
Extremadura	16,226,812	337,074	183,480	33,423	16,039,795
Galicia	58,374,468	1,488,196	949,212	80,210	57,755,275
Community of Madrid	259,796,320	3,203,195	6,966,887	271,782	263,288,230
Region of Murcia	27,410,990	1,029,408	482,927	45,795	26,818,714
La Rioja	8,289,570	143,788	218,192	18,563	8,345,411
Ceuta and Melilla	4,301,837	168,279	69,773	3,294	4,200,037
Total, Common Regime	**1,113,190,122**	**21,632,430**	**23,786,257**	**1,672,037**	**1,113,672,125**

Table A.3.2. Territorial distribution of the dynamic bracket creep due to non-indexation of tax schedules (2022)

Autonomous community	General income tax schedule	Savings tax schedule	Dynamic bracket creep
Andalusia	10,011,912	106,007	10,117,919
Aragon	2,569,834	26,120	2,595,955
Principality of Asturias	1,960,654	15,050	1,975,704
Balearic Islands	1,801,040	41,042	1,842,082
Canary Islands	2,796,883	34,022	2,830,905
Cantabria	1,110,275	11,028	1,121,303
Castile and León	4,298,479	40,803	4,339,282
Castile-La Mancha	2,642,997	21,477	2,664,474
Catalonia	16,074,277	230,891	16,305,167
Valencian Community	7,377,556	111,397	7,488,954
Extremadura	1,227,665	7,682	1,235,347
Galicia	3,963,459	39,010	4,002,469
Community of Madrid	14,737,978	237,914	14,975,893
Region of Murcia	1,887,210	21,473	1,908,683
La Rioja	625,620	9,634	635,254
Ceuta and Melilla	251,522	3,349	254,872
Total, Common Regime	**73,337,364**	**956,899**	**74,294,263**