



# The Mathematics Behind Your Tax Bill

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# OUTLINE

## TAXES

MATH-The Core of Tax Systems

Taxes as Mathematical Systems

2026 Tax Reforms-The One Big Beautiful Bill Act (OBBA)

# THE MATTER OF TAXES....



What do farmers use when they do their taxes?

*-A cow-culator.*

Guess which Avenger paid the least taxes this year?

*-Spiderman, because his entire income was net income.*

Why do they call gross pay gross pay?

*-Because it's disgusting to see how much you could've made before they took it all in taxes.*

What is the difference between an electron and a proton for a tax collector?

*-They are charged differently.*

Why did the chocolate shop's taxes get audited?

*-The owner had fudged the numbers.*

What kind of tax is placed on paper?

*-A tear-iff.*

Why are Sherlock Holmes' taxes so low?

*-He's a master of deduction.*



# Taxes

Mandatory financial contributions imposed by governments on individuals and businesses to fund public services and infrastructure.

They serve as the backbone of a functioning society by enabling governments to provide essential services that individuals cannot efficiently supply on their own.

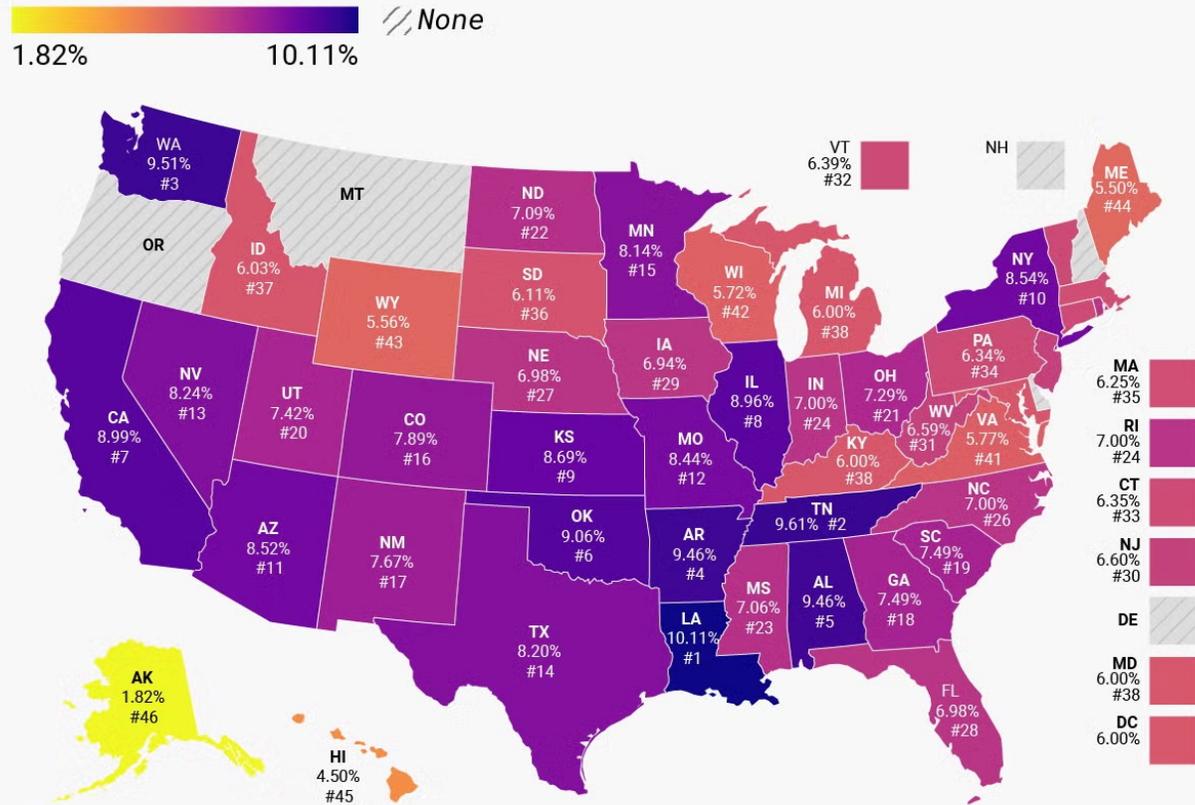
# Different Tax Categories



Tax Type	Description
<b>Income Tax</b>	Levied on individual earnings
<b>Sales Tax</b>	Added to goods and services purchased
<b>Property Tax</b>	Based on real estate value
<b>Corporate Tax</b>	Imposed on business profits
<b>Excise Tax</b>	Applied to specific goods like fuel or tobacco

# How High Are Sales Taxes in Your State?

Combined State & Average Local Sales Tax Rates, January 2026



Highest:  
Louisiana - 10.11%

Lowest:  
Alaska - 1.82%

0%:  
Oregon  
Montana  
New Hampshire  
Delaware

Second Highest!  
Tennessee - 9.61%

Note: City, county, and municipal rates vary. These rates are weighted by population to compute an average local tax rate. The sales taxes in Hawaii, New Mexico, and South Dakota have broad bases that include many business-to-business services.

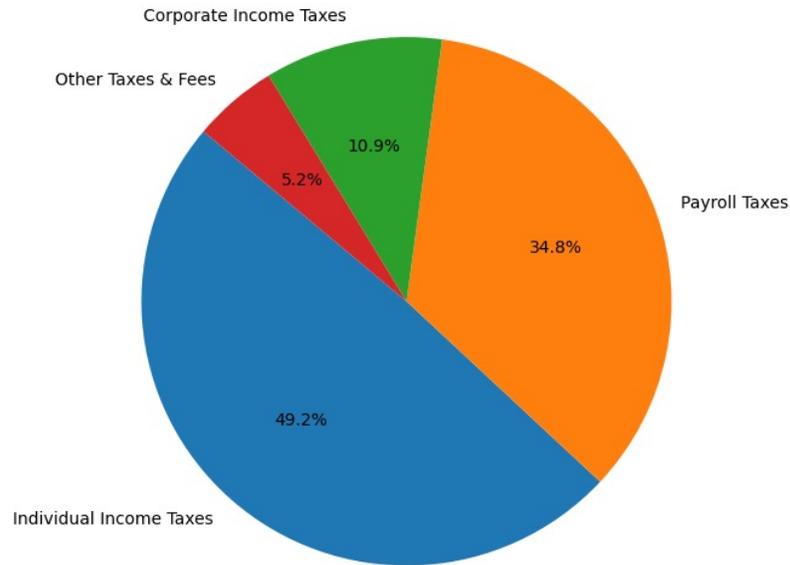
Source: Sales Tax Clearinghouse; Tax Foundation calculations; State Revenue Department websites.

# Why Do Sales Tax Rates Differ Across the U.S.?

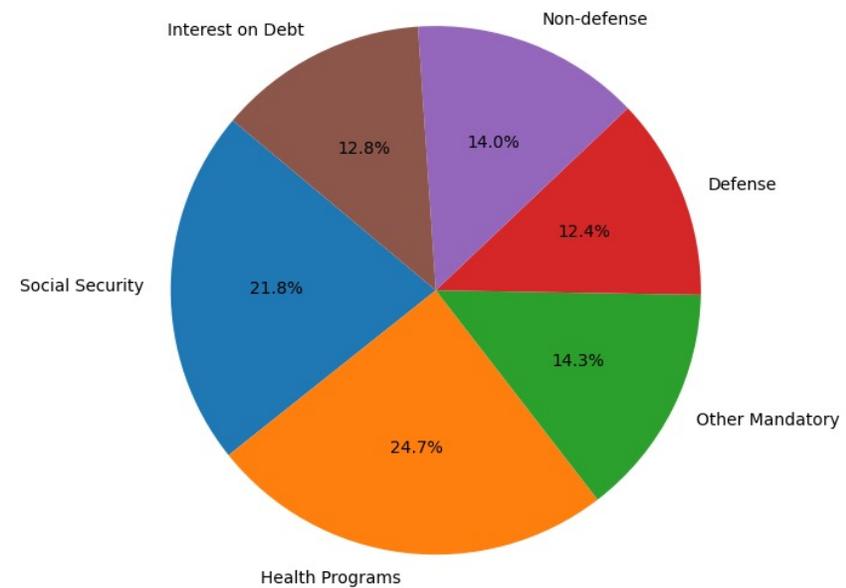
- Different Revenue Needs: States rely on sales tax differently based on budgets and services.
- Local Add-On Taxes : Cities and counties often add their own taxes, creating thousands of tax zones.
- Economic Competition: No-tax states attract shoppers; tax holidays encourage spending.
- Different Items Are Taxed : Groceries, medicine, clothing exemptions vary by state, changing effective tax burdens.
- State Policy Freedom: States independently set tax systems based on autonomy and priorities.

# U.S. Federal Tax Revenue & Spending Breakdown (FY 2024)

U.S. Federal Revenue Breakdown (FY 2024)

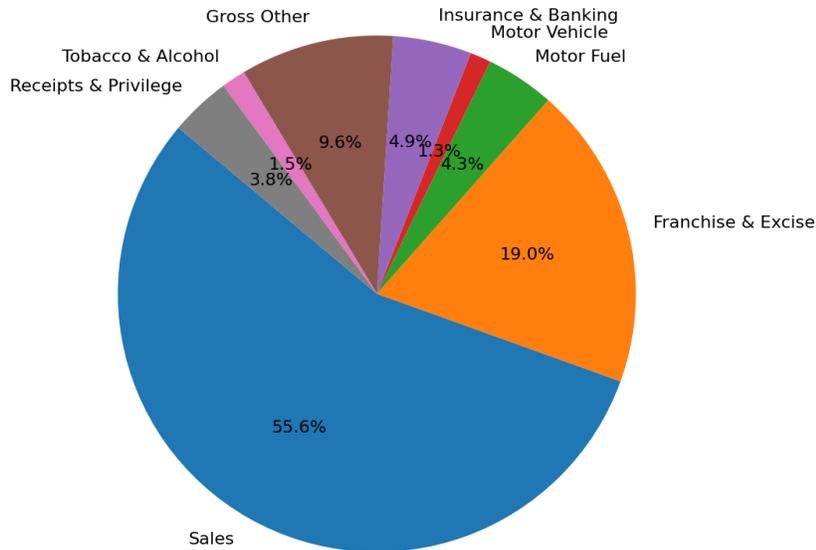


U.S. Federal Spending Allocation (FY 2024)

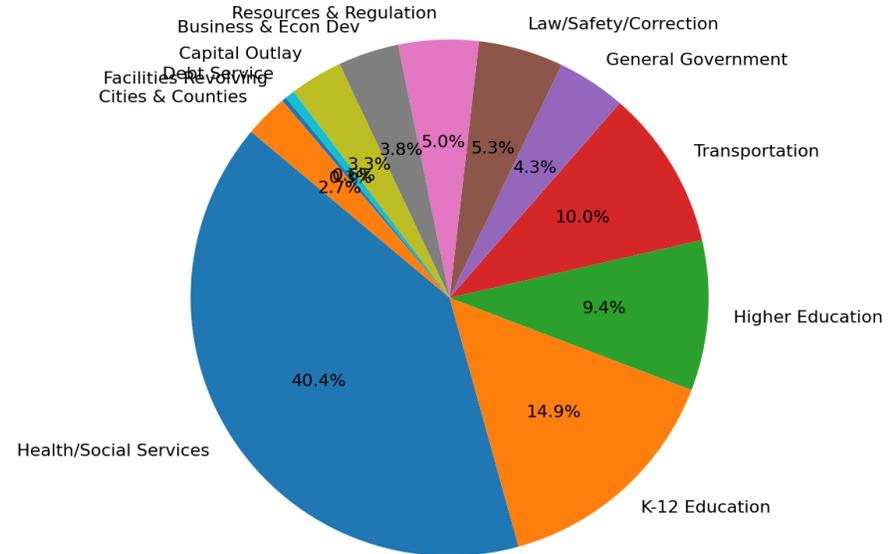


# TN Tax Revenue & Spending Breakdown (FY 2024)

Tennessee Tax Revenue Sources (FY 2023-24)



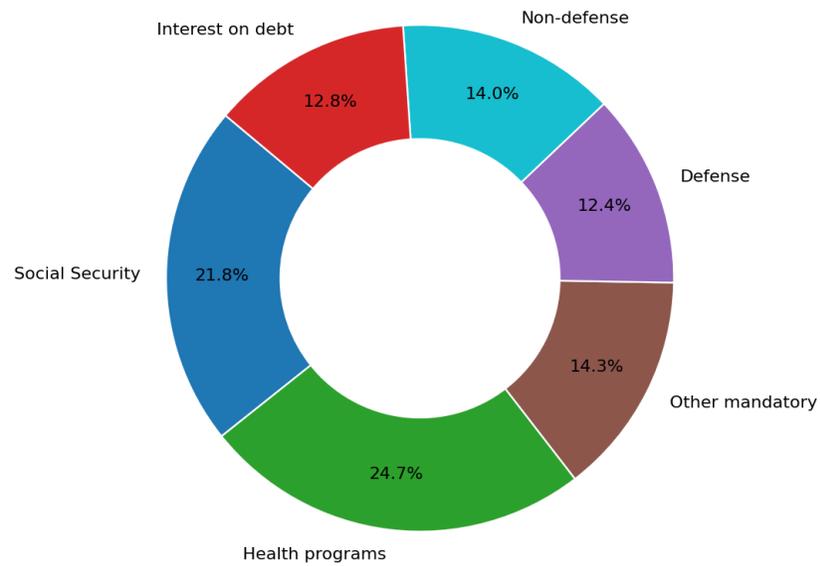
Tennessee Spending Allocation (FY 2023-24)



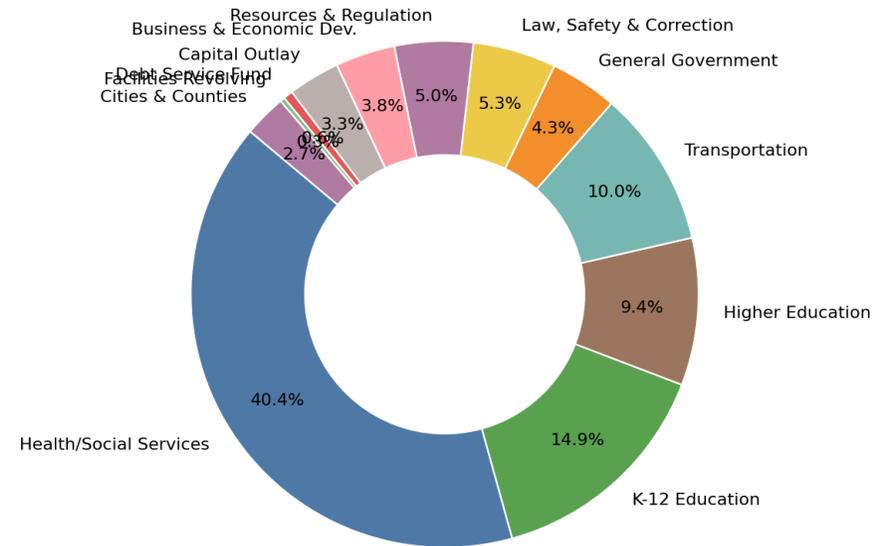
TN Revenue Breakdown	TN Spending Allocation
Individual income taxes: \$2.4T	Social Security: \$1.5T
Payroll taxes: \$1.7T	Health programs: \$1.7T
Corporate income taxes: \$530B	Other mandatory: \$981B
Other taxes & fees: \$253B	Defense: \$850B
	Non-defense: \$960B
	Interest on debt: \$881B

# U.S. vs TN Spending Breakdown (FY 2024)

U.S. Federal Spending Allocation (FY 2024)



Tennessee Spending Allocation (FY 2024)



Sources: CRFB (FY 2024 federal outlays) and Tennessee General Assembly 2023-24 Factbook (state functional shares). Note: Categories differ; shares show composition within each government level for FY 2024.

# Tax Collection Process: Withholding, Filing, and Refunds



## Tax Withholding System

Employers deduct estimated taxes from wages to ensure steady government revenue and reduce year-end balances.

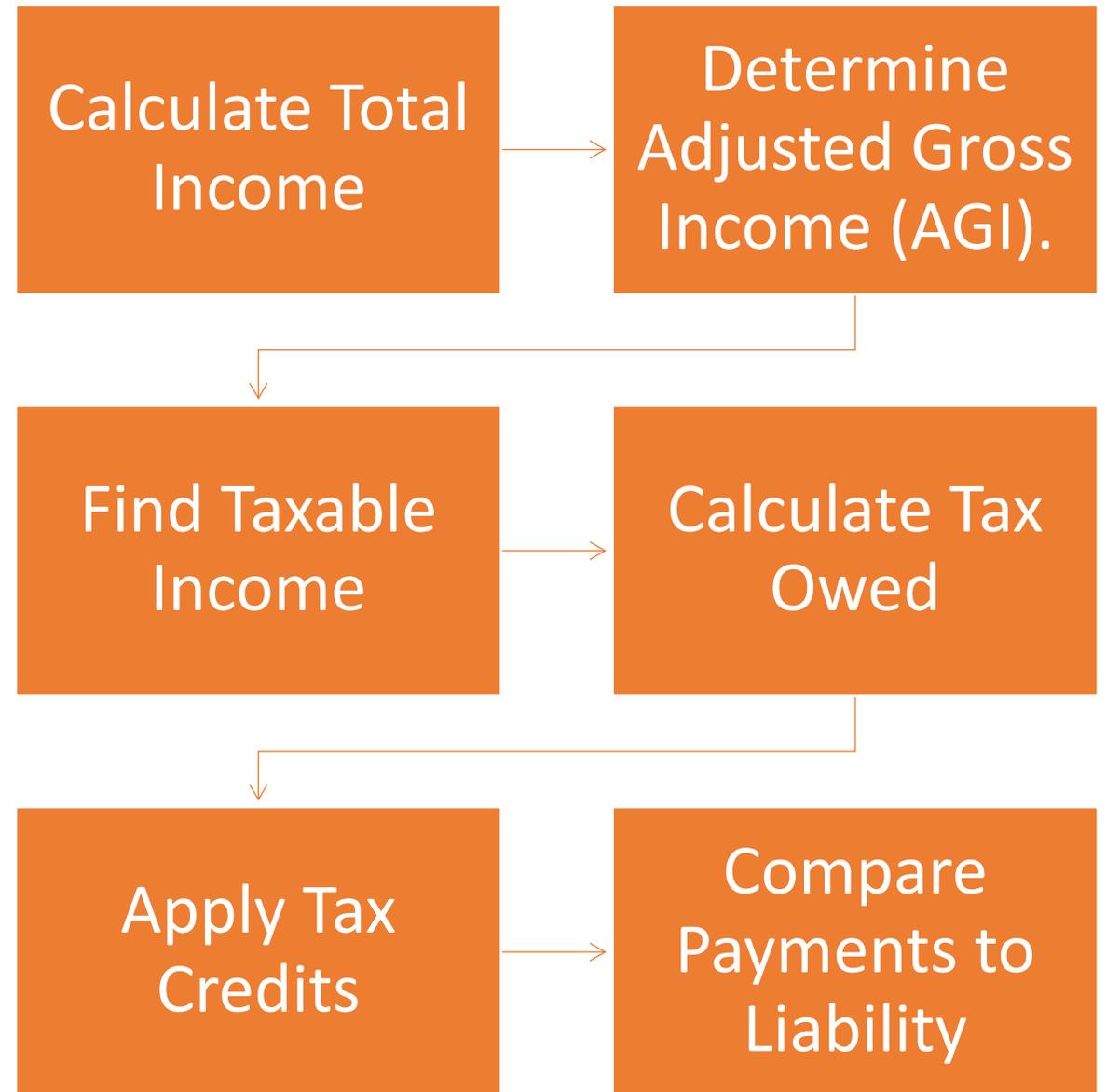
## Annual Tax Filing

Individuals file annual tax returns reporting income, deductions, and credits to reconcile tax liability with the IRS.

## Tax Refunds and Payments

Taxpayers receive refunds if they overpay, or pay additional amounts if they underpay, balancing their tax obligations.

# Filing Taxes





## Math –The Core of Tax Systems

# Basic Tax Calculation Formula

Tax formulas provide a structured framework for calculating liabilities and verifying accuracy. The most common formula,

$$(Income - Deductions) \times Tax Rate = Tax Owed.$$

serves as the foundation for determining how much an individual or business must pay.

This formula simplifies complex tax rules into actionable steps.



# Variations for Special Taxes



Variations of this formula apply to different contexts, such as calculating self-employment taxes, where additional percentages for Social Security and Medicare are factored in.

# Tax Credits Computation



Mathematical Formulas govern the computation of credits, such as the Earned Income Tax Credit, which involves income thresholds and phase-out ranges.

# Scenario Planning and Accuracy



Formulas also help in scenario planning, enabling individuals to assess the impact of additional income, deductions, or credits on overall tax liability.

In more complex situations involving investments, business income, or multi-state filings, advanced math skills become even more critical.

These scenarios often require interpreting intricate formulas, applying multiple tax rates, and analyzing financial data.

# Financial Management



Accurate tax math is essential for sound financial management, influencing both short-term cash flow and long-term wealth planning. Overpaying taxes can strain liquidity, while underpaying may result in penalties, interest, and legal complications.

# Beyond error prevention



With an appreciation of mathematics;

-Individuals can optimize deductions, identify eligible credits, and strategically plan contributions to retirement accounts or other tax-advantaged vehicles.

-Businesses benefit similarly by managing payroll taxes, forecasting quarterly payments, and aligning tax strategies with operational goals.

# Basic Arithmetic Operations in Tax Filing

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<b>OPERATION</b>	<b>TAX APPLICATION</b>
<b>Addition</b>	Summing income sources and credits
<b>Subtraction</b>	Deducting expenses and exemptions
<b>Multiplication</b>	Applying tax rates to taxable income
<b>Division</b>	Calculating installment payments or prorated amounts

# Percentages and Tax Rates

## Tax Brackets and Percentages

Tax brackets use percentage ranges to tax income progressively, with higher rates for higher earnings.

## Payroll and Sales Taxes

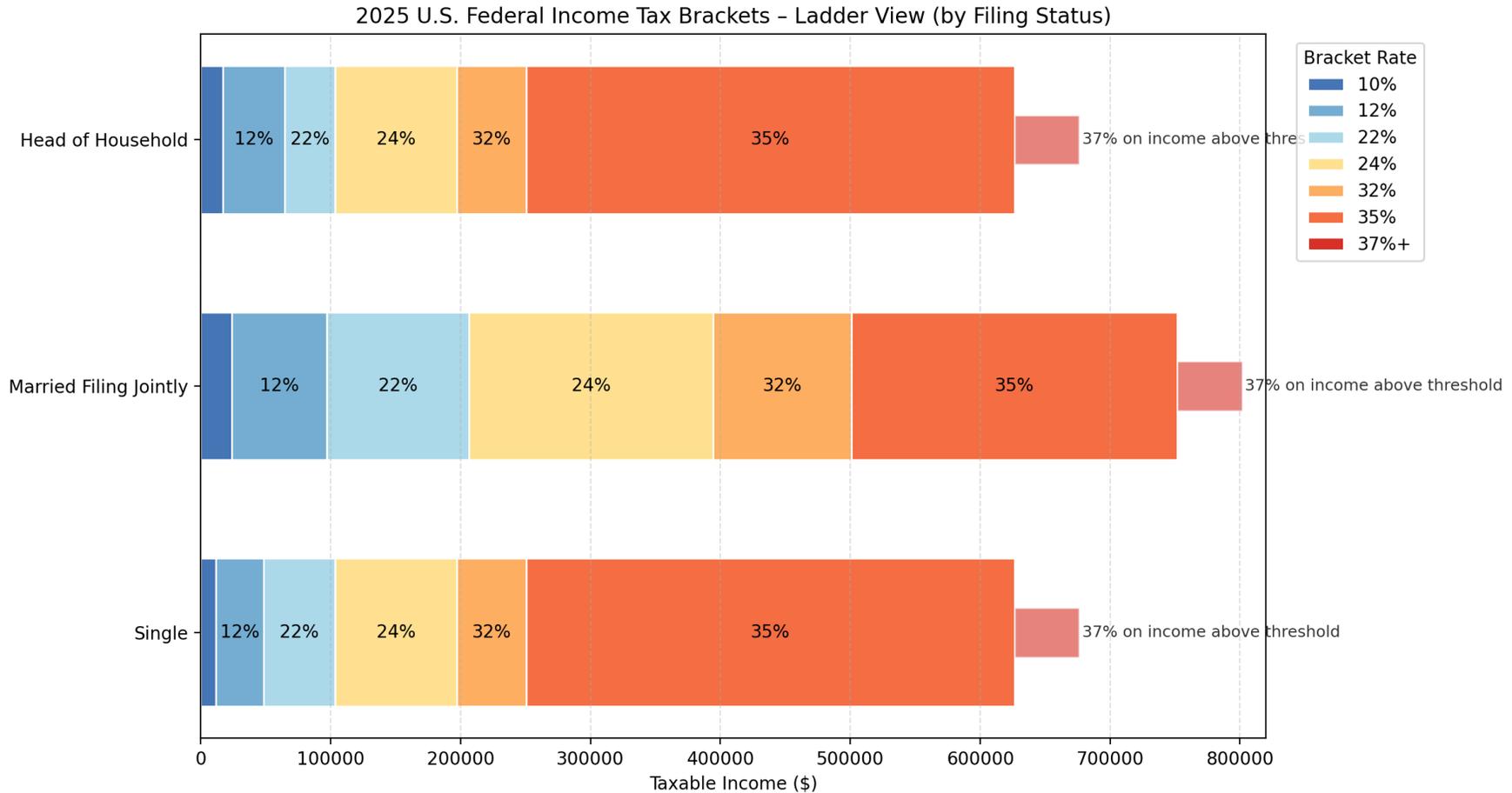
Payroll and sales taxes are percentage-based, deducted directly from wages or purchase prices respectively.

## Importance of Accurate Calculations

Precise percentage calculations ensure compliance, prevent misclassification, and maximize tax benefits.



# 2025 U.S. Federal Tax Brackets – Ladder View





# Taxes as Mathematical Systems



# Phase-outs

**A tax phase out is the gradual reduction or elimination of a tax benefit (such as a credit or deduction) as a taxpayer's income increases beyond a certain threshold.**

**E.g. a taxpayer who is eligible for a \$100 credit might see that credit reduced by \$10 for every \$1,000 they earn above the \$100,000 threshold. If they earn \$105,000, their credit would be \$50.**

# Deductions vs Credits

Deductions reduce taxable income, while credits directly reduce the tax owed, dollar-for-dollar, making credits significantly more impactful.

For instance, a \$1,000 deduction might save \$220 in taxes for someone in the 22% bracket, whereas a \$1,000 credit saves the full \$1,000.



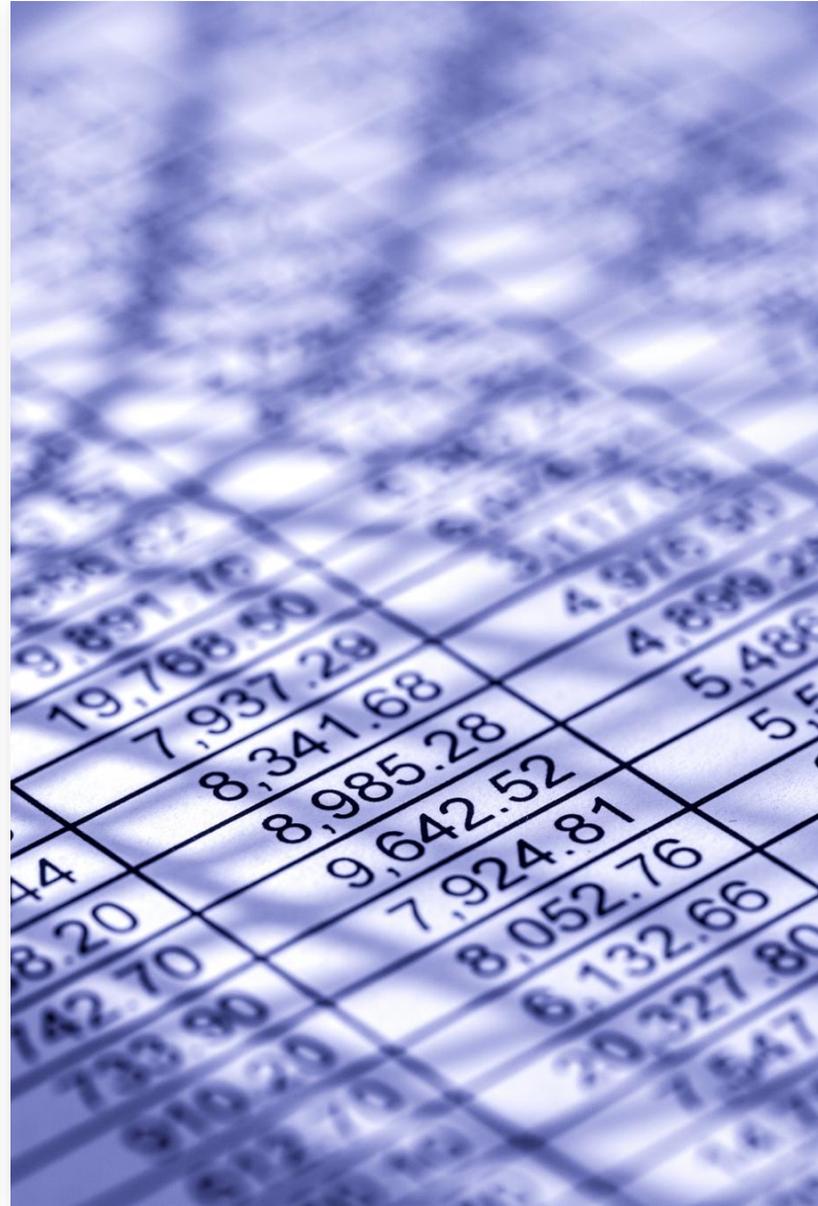


# Beyond Simple Percentages

The mechanics of deductions and credits along with additional layers like phase-outs extend tax computation extends far beyond applying a single percentage to income.

They transform tax filing into a multi-step optimization problem, where understanding the interplay between deductions, credits, and income thresholds can yield substantial savings.

For math enthusiasts, this complexity offers an intriguing challenge, blending algebraic reasoning with real-world constraints, but it also underscores why tax systems are often perceived as opaque and intimidating.



# Taxes as Complex Piecewise Functions

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From a mathematical standpoint, taxes are not a simple linear equation but rather a series of interconnected piecewise functions.

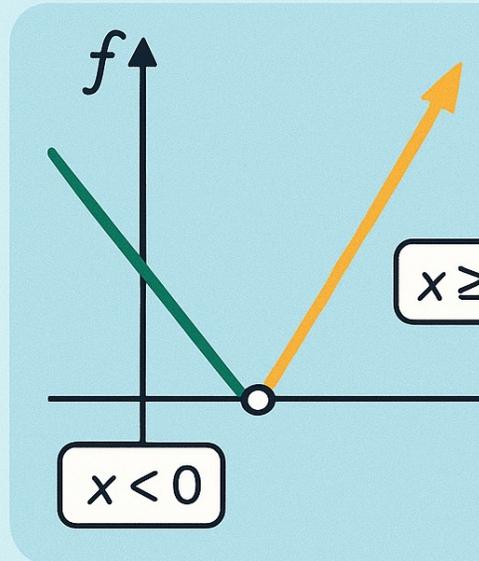
Each income bracket applies a different marginal tax rate, creating a segmented structure where calculations depend on intervals rather than a single formula.

For example, the first \$10,000 of one's income might be taxed at 10%, the next \$30,000 at 12%, and so on.

# Piecewise Functions

## Understanding Piecewise Functions

Different rules  
in different regions.



A piecewise function is just a rule that changes depending on the situation.

E.g. Taxes use brackets, not one flat rate.

First \$11,000  $\rightarrow$  10%

Next \$33,000  $\rightarrow$  12%

Income above that  $\rightarrow$  22%

Observe that Each bracket is a different piece.

# Myth Buster....

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Myth-“If I move into a higher tax bracket, *all* my income is taxed more.”

✓ Reality:  
Only the **next piece** follows the new rule.

*Piecewise functions prevent sudden jumps*



# Some logic please?.....

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Tax computations involve conditional logic and cumulative sums across brackets.

This complexity is compounded by deductions, credits, and phase-outs, which alter taxable income and effective rates.

# Fair vs Strategic

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Progressive taxation aims to align tax burden with ability to pay, but its implementation raises questions about behavioral incentives.

It creates opportunities for multi-step optimization strategies, such as income shifting or timing deductions.

# Game Theory and Strategic Behavior

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The tax code resembles a lottery or strategy games where knowledge of loopholes and benefit cliffs lead to complex, non-linear responses.



# Mathematical Complexity and Human Unpredictability

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While Game theory tries to predict strategic responses, real-world decisions often defy these models due to psychological factors and imperfect information.

Thus, tax systems become a fascinating study in applied mathematics, where optimization intersects with human unpredictability.



# Economic and Social Dimensions of Tax Math

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Beyond calculations, taxes embody economic and social principles that mathematicians analyze through models of fairness and efficiency.

This perspective highlights the tension between theoretical ideals of equity and practical compromises driven by politics and economics, making tax policy a rich domain for mathematical inquiry.



# Frustrations with Real-World Complexity

## **Limitations of Idealized Models**

Ideal models assume rational actors, but taxpayers often act based on emotions or incomplete information.

## **Tax Code Complexity**

The tax code is vast and intricate, with numerous rules and frequent changes that resist simplification.

## **Need for Interdisciplinary Thinking**

Solving real-world tax problems requires understanding law, economics, psychology, beyond mathematical equations.



# Tax Breaks for Retirement Accounts (401(k), IRA, Roth IRA)

- Retirement accounts offer **tax advantages** that help you save more efficiently. The specifics differ by account type, but they usually fall into three categories:
  - **Upfront tax deductions**
  - **Tax-deferred growth**
  - **Tax-free withdrawals**

# Tax Breaks for Retirement Accounts (401(k), IRA, Roth IRA)

Account Type	Upfront Tax Break	Tax-Free Growth	Tax-Free Withdrawals
<b>Traditional 401(k)</b>	Money you contribute reduces your taxable income for the year.	Tax deferred growth: Investments grow without being taxed until withdrawal.	No
<b>Traditional IRA</b>	Contributions may be tax-deductible, depending on income and whether you have a workplace retirement plan.	Tax-deferred growth until withdrawal.	No
<b>Roth IRA</b>	No upfront deduction, but withdrawals in retirement are tax free if rules are met.	Contributions grow tax free.	Yes
<b>Roth 401(k)</b>	Contributions are made with after-tax dollars.	Contributions grow tax free.	Yes: Qualified withdrawals (usually after age 59½ and 5 years in the plan) are tax-free.

# Employer Matching = Tax-Deferred Free Money

Many employers match part of your contributions.

Matches are not taxed when contributed

Employer contributions to your account are not counted as taxable income in the year you receive them.

They also grow tax-deferred.

This match is often described as “free money”—and it's tax-advantaged.

# Saver's Credit (Extra Benefit for Moderate-Income Earners)

If an individual's income is below certain thresholds, the 401(k) contribution may qualify such a person for the Saver's Credit, a federal tax credit worth up to 50%, 20%, or 10% of your contribution (depending on income)

This is a dollar-for-dollar reduction of taxes owed—not just a deduction.

# How Tennessee Tax Law Affects Retirement Account Tax Breaks

No State Income Tax (TN)  
No tax on wages or retirement income.

Retirement savings are only taxed at the federal level, and TN does not reduce, limit, or modify any of the federal tax advantages.

No State-Level Credits or Deductions for Retirement Contributions  
Since TN doesn't tax income.

Tennessee does not tax:  
any IRA or 401(k) withdrawals.  
Social Security benefits.  
investment income since the Hall Income Tax was fully repealed in 2021.

TN residents only deal with:  
Federal rules for Traditional IRA deductibility  
Federal limits for Roth IRA contributions  
Federal limits for 401(k), 403(b), 457, and TSP contributions  
Federal Saver's Credit (TN imposes no restrictions)

So, if you live in Clarksville, TN;

Federal tax breaks apply fully  
No state tax on retirement savings—ever on withdrawals from: Traditional IRAs, Roth IRAs, 401(k), 403(b), and 457 plans, Pensions  
Social Security.

Making both Traditional and Roth strategies more flexible, since no state-level tax considerations affect the decision.

# Which Should You Choose in Tennessee?

If you want the biggest tax break today → Traditional

*You get meaningful federal deductions, and TN won't tax you later.*

If you want tax-free income later → Roth

*Your withdrawals will be tax-free federally, and TN also won't tax them.*

If unsure → Consider a mix

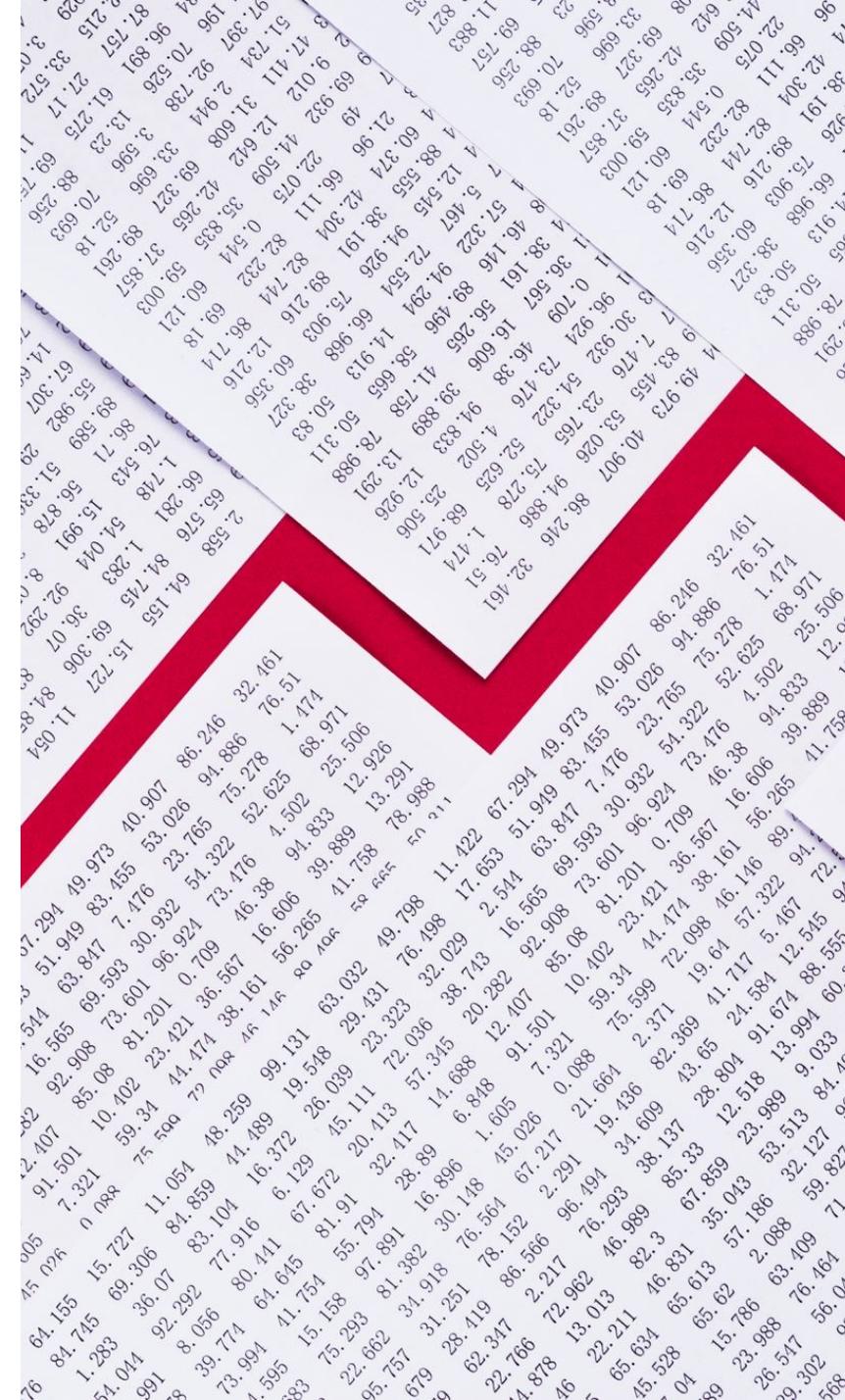
*Many TN retirees benefit from holding both for flexibility in different tax environments.*

# 2026 Tax Reforms-The One Big Beautiful Bill Act (OBBBA)

The bill was passed in July 2025.

It shapes the 2026 tax year.

It makes most 2017 TCJA tax cuts permanent and introduces new deductions and expanded credits.



# Standard Deduction Changes

Standard deductions rise modestly (about \$350–\$700 depending on filing status).

FILING STATUS	2025	2026
Single / Married Filing Separately	\$15,750	\$16,100
Married Filing Jointly	\$31,500	\$32,200
Head of Household	\$23,625	\$24,150

A white calculator is positioned on the left side of the image, resting on a document. The calculator's display is dark, and its keypad features various function keys like 'M+', 'M-', 'MRC', and 'MC', along with standard numerical keys. The background is a soft-focus document with some text and a grid pattern.

# Income Tax Bracket Threshold Adjustments

Tax rates remain the same (10%–37%), but income thresholds shift due to inflation and OBBB. Many taxpayers avoid bracket creep and may owe slightly less tax even with similar income.

Changes from 2025 → 2026:

Lower brackets rise **~4%**, higher brackets **~2.3%**.

22% bracket in 2026 starts at \$50,400 (single) and \$100,800 (joint).

Top 37% bracket in 2026 starts at \$640,600 (single) and \$768,700 (joint).

# Income Tax Bracket Threshold Adjustments

<b>Marginal rates</b>	<b>Single / Married Filing Separately</b>	<b>Married Filing Jointly</b>
10%	Up to \$12,400	Up to \$24,800
12%	\$12,401 - \$50,400	\$24,801 - \$100,800
22%	\$50,401 - \$105,700	\$100,801 - \$211,400
24%	\$105,701 - \$201,775	\$211,401 - \$403,550
32%	\$201,776 - \$256,225	\$403,551 - \$512,450
35%	\$256,226 - \$640,600	\$512,451 - \$768,700
37%	\$640,601 or more	\$768,701 or more

# New and Temporary Deductions

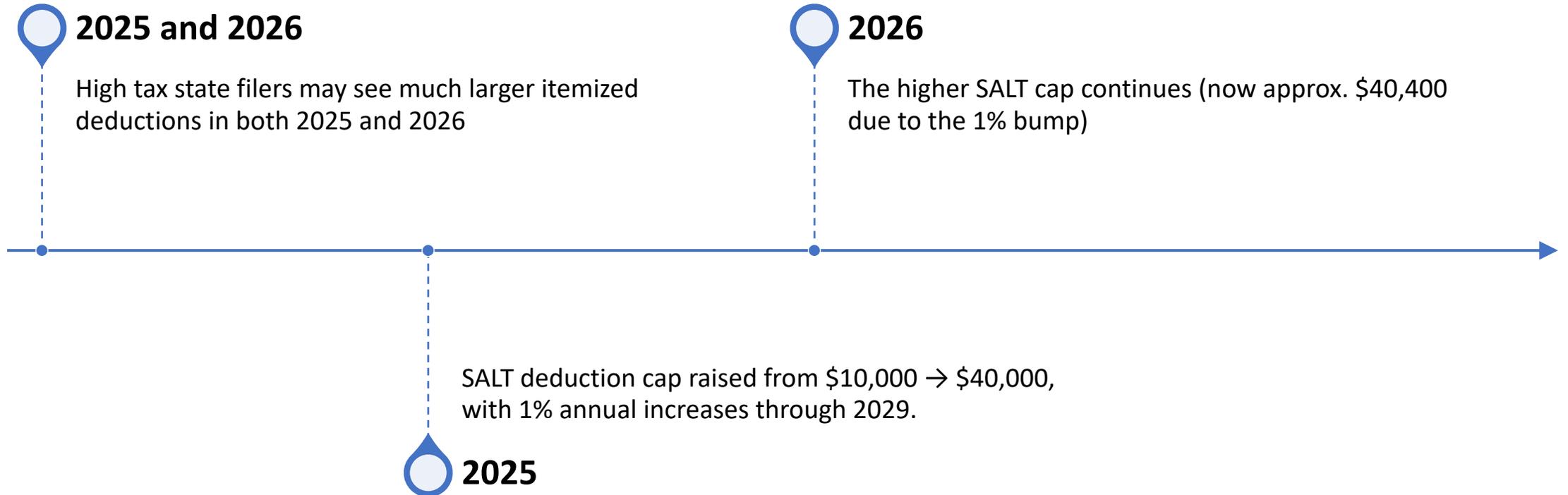
Several provisions begin or expand in **2026** (some already apply to 2025 filings); however, 2026 marks the first full year with multiple new worker-focused deductions.

## **New above-the-line deductions (2025–2028)**

- Up to \$25,000 deductible for reported tips.
- Vehicle loan interest deduction (up to \$10,000).
- Overtime tax relief (up to \$12,500).
- Seniors (65+) receive an extra \$6,000 per person, through 2028.



# State & Local Tax (SALT) Deduction Cap Temporary Increase





## Alternative Minimum Tax (AMT) Adjustments

AMT thresholds increase from 2025 → 2026, reducing AMT liability for many filers.

### **2026 AMT exemption:**

Single: \$90,100, phaseout at \$500,000.

Married filing jointly: \$140,200, phaseout at \$1,000,000.

# Child, Estate & Adoption Tax Credits



Slight inflation-driven increases.

## **Child Tax Credit:**

Increased to \$2,200 per child (inflation-adjusted).

## **Estate tax exclusion:**

2025: \$13.99 million

2026: \$15 million

## **Adoption credit:**

2025: \$17,280

2026: \$17,670.

# Inputs Provided

Filing status: Married Filing Jointly

Income: \$90,000 (2026)

Age: 50

Overtime: \$2000

Tips: No

Dependents: Yes (eligible for CTC)



# TAX

55,800

## Step 1 — Standard and overtime Deduction

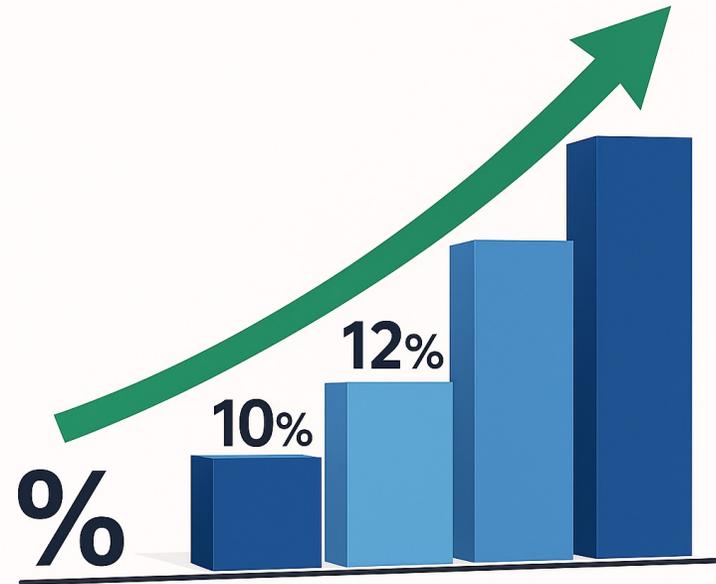
2026 Standard Deduction:  
\$32,200 (Married Filing Jointly)

Overtime deductions

Taxable income = \$90,000-  
\$32,200-\$2,000 = \$55,800

# Step 2 — 2026 Tax Brackets

- Taxable income falls in 12% bracket
- Brackets (Married Filing Jointly)
- 10%: up to \$24,800
- 12%: \$24,801–\$100,800





## Step 3 — Federal Tax Calculation

## Step 4 — Child Tax Credit

Assume 1 dependent → \$2,200 credit

Tax after credit = \$6,200 - \$2,200 = \$4,000

# What if the individual were filing single?

**Deductions:**  $\$90,000 - \$16,100 - \$2,000 = \$71,900$

## **Tax brackets**

10%  $\$12,400 = \$1,240$

12%  $50,400 = \$6,048$

22%  $9,100 = \$2,002$

Total =  $\$9,290$

## **Credits**

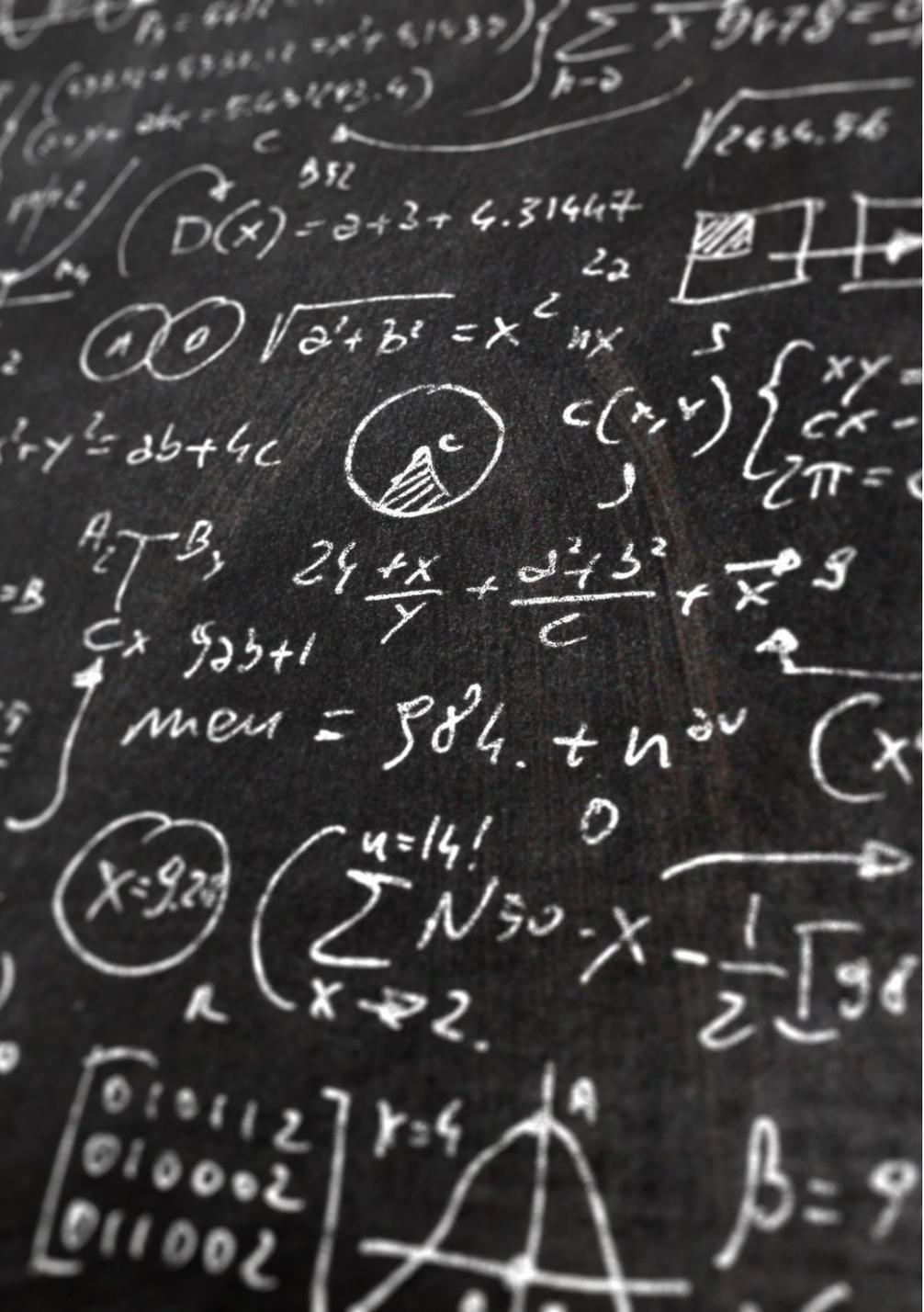
Child credit =  $\$9,290 - \$2,200 = \$7,090$



## In summary

Taxes represent a complex interplay of mathematical structures, economic incentives, and social objectives.

At their core, they function as piecewise systems that apply different rates to segmented income ranges, but in practice, they involve layers of deductions, credits, and behavioral responses.



## In summary

For mathematicians, this complexity offers both beauty and frustration: beauty in the logical architecture of progressive taxation and optimization strategies, and frustration in the chaotic reality of ever-changing laws and irrational decision-making.

Taxes challenge the notion that mathematics alone can solve societal problems, revealing that fairness and efficiency are not purely quantitative goals but value-laden concepts shaped by politics and culture.

# In summary



Ultimately, viewing taxes through a mathematical lens deepens our appreciation for their role as a mechanism for resource allocation and social engineering, while reminding us that even the most rigorous models must contend with human unpredictability.

This perspective transforms tax policy from a dry administrative task into a dynamic field of inquiry, where logic meets life in all its complexity.



THANK YOU FOR LISTENING