A counterfactual analysis of Bitcoin and gold allocations to USA 'Rainy Day Funds': supporting state lawmakers' decision-making

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Abstract

Rainy Day Funds (RDFs) help USA state governments manage fiscal shortfalls and shocks but often rely on low-risk, low-yield investments that erode under inflation. We examined whether partial allocations to Bitcoin and gold could have bolstered RDF performance from 2018 to 2024. Using historical prices, RDF flows, and inflation data, we compare asset mixes (0–10% each for Bitcoin and gold) against a 'risk-free' interest rate baseline. Modest Bitcoin allocations (3% or more) consistently hedge inflation, boosting real returns above the baseline. Gold aids stability but needs higher allocations for comparable effect. State RDF performance hinges on the timing of contributions and withdrawals relative to Bitcoin's price cycles. Our results suggest that adding these investments can help to preserve purchasing power for state governments.

Keywords

Bitcoin allocation; budget stabilization fund; fiscal resilience; inflation protection; portfolio diversification; rainy day funds

1. Introduction

U.S. states maintain Rainy Day Funds (RDFs) to mitigate unforeseen budget shortfalls and economic downturns (Knight and Levinson, 1999; Pollock and Suyderhoud, 1986; Wagner and Elder, 2005). Historically, these funds have been held in low-volatility, liquid instruments such as treasuries and short-dated government bonds to preserve principal and ensure ready access to cash. While conservative strategies minimize market risk, they remain vulnerable to inflation, limiting long-term growth.

RDFs, also known as budget stabilization funds, originated in the mid-20th century to counter economic instability and volatile tax revenues. Early versions helped smooth state budgets during recessions or fiscal stress, enabling governments to maintain essential services without resorting to drastic tax hikes or spending cuts (Pollock and Suyderhoud, 1986; Wagner and Elder, 2005). Over time, the funds were institutionalized through constitutions and statutes, with most states formalizing rules for contributions, withdrawals, and target funding levels (Rodríguez-Tejedo, 2012). By the early 2000s, RDFs were considered pillars of prudent fiscal management, helping states endure shocks like financial crises and, more recently, the COVID-19 pandemic (Walczak and Cammenga, 2020) and the 2024 floods in North Carolina.

Despite their importance, RDFs face persistent challenges. Prolonged low interest rates have curtailed returns on ultra-conservative investments, eroding purchasing power amid rising inflation. The uneven pace of economic recovery also complicates replenishment, heightening volatility and limiting preparedness for future downturns. Furthermore, strict legal and policy frameworks in many states (Rodríguez-Tejedo, 2012) confine RDFs to low-risk instruments, impeding opportunities for growth. These issues highlight the need for innovative strategies that balance liquidity, safety, and real-value preservation.

Satoshi Action Education educates the public and policymakers about Bitcoin technology and policy through policy reports, in-person lawmaker engagement, and peer-reviewed research. With multiple states now exploring legislation to allow RDFs to invest in gold and Bitcoin—including a 2024 Utah measure permitting gold—Satoshi Action Education, in response to repeated requests from state analysts and lawmakers, developed a simple counterfactual analysis to assess how varying allocations to these assets might have affected RDF performance historically, focusing on preserving purchasing power.

In this case study, we explore whether partial allocations to Bitcoin and gold might have delivered improved nominal and inflation-adjusted performance over the past seven years (2018-2024), a period of economic swings and volatile interest and inflation rates. The central question is whether modest positions in these asset classes could have helped states preserve—or even enhance—the real (deflated) value of their RDFs. By conducting a counterfactual analysis of various portfolio compositions, we seek to inform policymakers,

budget analysts, and other fiduciaries about both the potential benefits of diversification. Ultimately, by comparing hypothetical allocation mixes, we hope to provide a base from which forward-looking RDF portfolio allocation models can be developed, providing state lawmakers with credible evidence that can support resilient fiscal policies.

2. Methodology

We conducted a counterfactual analysis of RDF performance based on daily asset price movements, inflation data, and historical RDF balances spanning 01 January 2018 to 31 December 2024. This approach models the impact of hypothetical allocations to gold and Bitcoin on fund returns relative to traditional RDF strategies.

2.1. Data

Historical 2018 to 2024 RDF data for all 50 states were sourced from the National Association of State Budget Officers (NASBO) (https://www.newyorkfed.org/markets/reference-rates/sofr). NASBO reports annual year-end balances, reflecting variability in RDF contributions and withdrawals across years. In the absence of precise transaction timing, we converted annual totals into daily flows, ensuring consistency across states for our analysis.

Daily Bitcoin closing prices (Figure 1) for 31 Dec 2017 to 2024 were obtained from Investing.com (https://ca.investing.com/crypto/bitcoin/historical-data). The starting point of 2018 aligns with the advent of Bitcoin futures availability and Bitcoin's increasing accessibility to institutional investors.

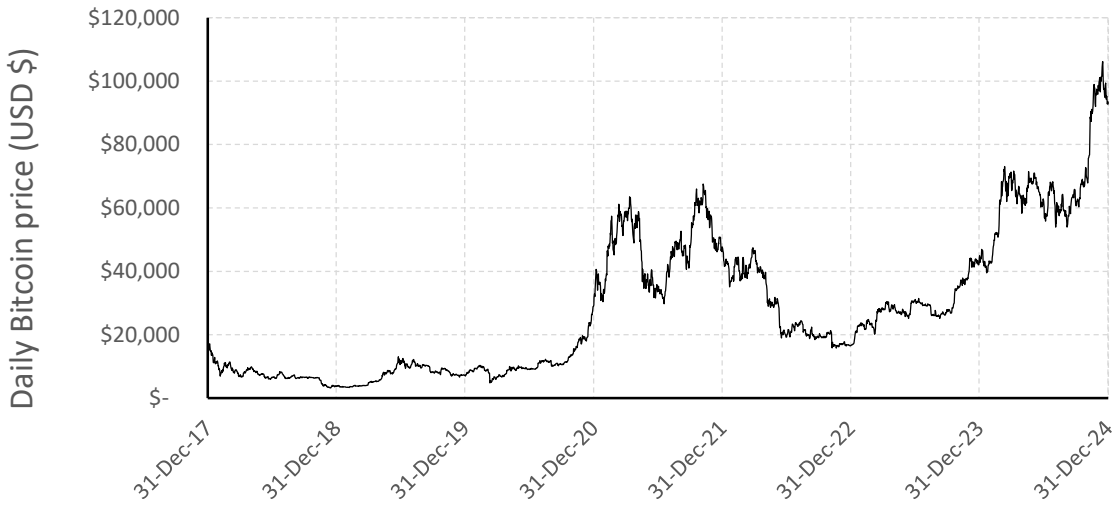

Figure 1: Bitcoin price history, December 31, 2017 to December 31, 2024

We use the London Bullion Market Association gold spot rate (https://ca.investing.com/indices/lbma-gold-fixing-price-historical-data) for our analysis (Figure 2), carrying forward the last market price prior to weekend and holiday market closures until the next day that markets re-open.

Figure 2: Gold price history, December 31, 2017 to December 31, 2024

Various interest-bearing investment strategies are available to RDFs. In this analysis, we use the Effective Federal Funds Rate (EFFR) as a standardized proxy for the 'risk-free' interest rate accessible to states (https://www.newyorkfed.org/markets/reference-rates/sofr). The EFFR, calculated as the volume-weighted median of overnight federal funds transactions, provides a consistent benchmark for short-term interest rates (Figure 3). This approach avoids variability introduced by differing treasury investment strategies across states, yet is closely correlated with treasury bill yields (Sarno and Thornton, 2003). As with gold, we carry forward rates from the last trading day over weekends and holidays.

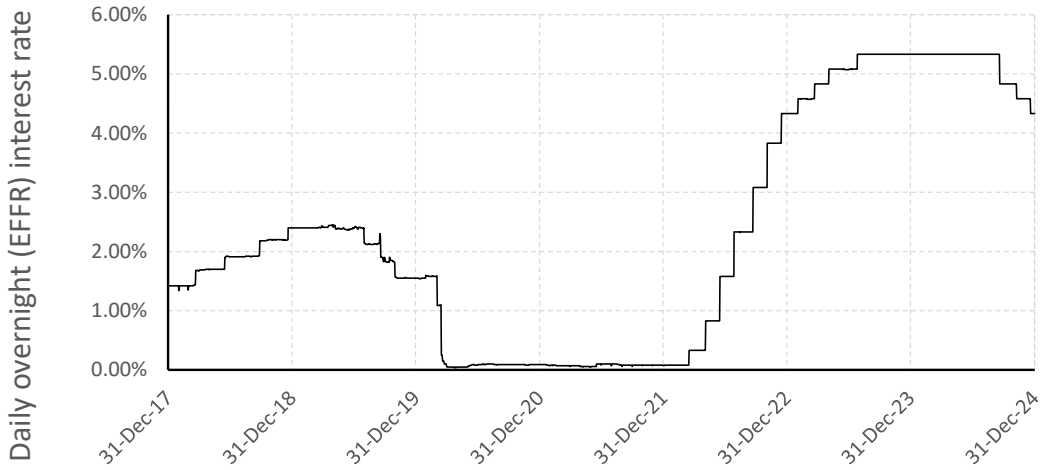

Figure 3: Overnight interest rates (EFFR), December 31, 2017 to December 31, 2024

Nominal values of state RDFs were transformed to real (01 January 2018 baseline) daily values using Federal Reserve data (https://fred.stlouisfed.org/series/MEDCPIM158SFRBCLE)[1]:

$$F_d = \left(F_a{}^{1}/_{12}\right)^{1}/_{N} \quad (1)$$

where F_d = daily inflation factor, F_a = annualized monthly inflation rate, and N = number of days in the month. Thus, the daily interest rate, r_d, that gives rise to a particular annualized monthly inflation rate is:

$$r_d = F_d - 1 \quad (2)$$

and daily CPI for each day in the month is calculated as:

$$CPI_t = CPI_{t-1}(1 - r_d) \quad (3)$$

Figure 4 shows that the CPI inflation index reached 130.69 by the end of the 7-year model time horizon. Inverting the inflation index, the total loss in purchasing power was 23.5% from 2018 to 2024.

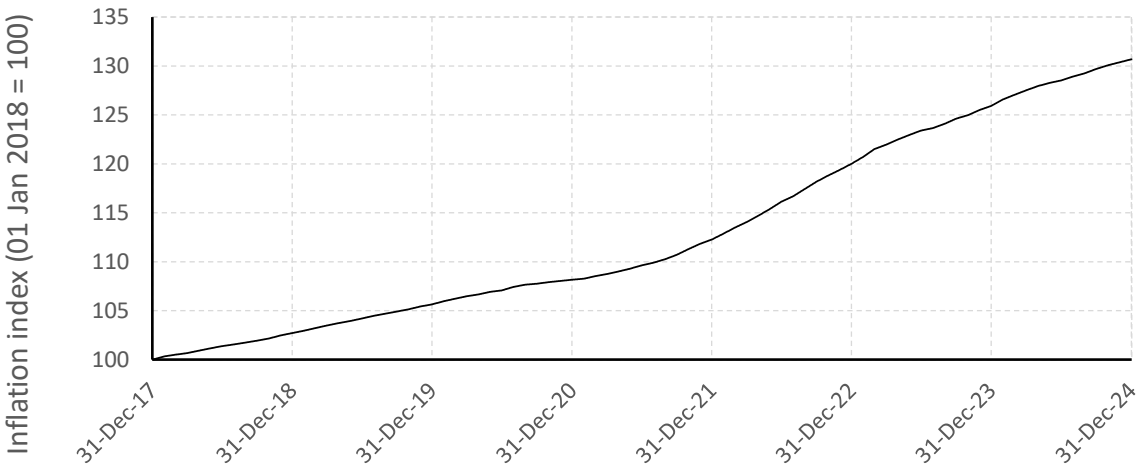

Figure 4: CPI index (01 January 2018 USD $ = 100)

2.2. Model structure

The analysis covered all 50 U.S. states individually, alongside a generic one-shot baseline investment scenario, using the Analytica platform (https://analytica.com/) (Figure 5).

[1] At the time of our analysis, December 2024 inflation numbers were not available from the Fed, so we used the latest anticipated level (https://www.forbes.com/sites/simonmoore/2024/12/17/what-to-expect-from-januarys-cpi-inflation-report/)

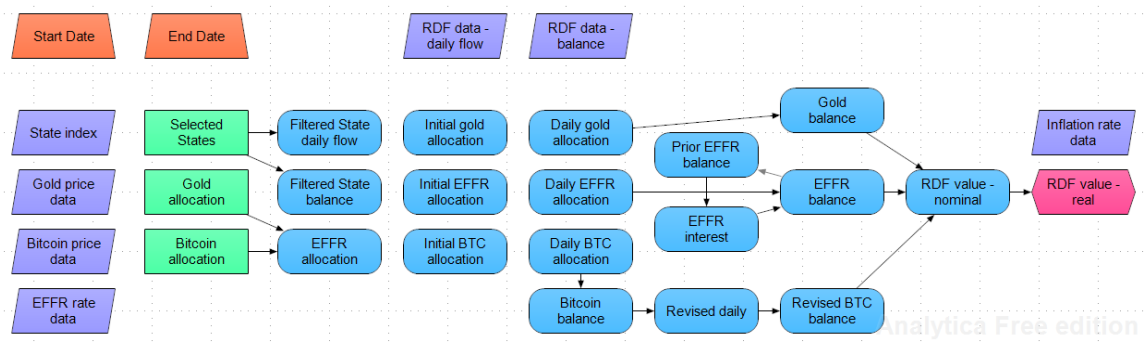

Figure 5: Model structure for analyzing nominal and real returns with various investment allocations

After calculating the model's time horizon and input data, choice variables were defined for all 50 states and portfolio allocations to Bitcoin and gold. Bitcoin allocation options included 0%, 1%, 2%, 3%, 5%, and 10%. Gold allocation options included 0%, 1%, 2%, 5%, and 10%. The remaining balance of each daily RDF allocation was directed entirely to the EFFR instrument.

2.3. Baseline analysis

To complement the state-level analysis, a baseline scenario was modeled using a one-time $10 million contribution on 01 January 2018, with no subsequent daily investments or withdrawals. This scenario provided a simplified view of asset allocation impacts on overall returns, facilitating compound annual growth rate (CAGR) calculations unaffected by daily cash flow complexities.

2.4. State-level analyses

State-level simulations began with each state's 31 December 2017 RDF balance, initializing allocations to the EFFR, gold, and Bitcoin on January 1, 2018. For subsequent daily time steps, new allocations were calculated in USD terms based on each state's RDF daily flows.

- **EFFR Allocations:** Daily interest income was computed from the prior day's balance using the overnight EFFR rate. Deposits and withdrawals were applied in USD terms.

- **Gold and Bitcoin Allocations:** New allocations were used for purchases or sales of gold and Bitcoin, with transactions executed at the daily market price. Running tallies of physical gold and Bitcoin holdings were maintained.

To address Bitcoin's higher price volatility (Ang et al., 2022; Baur and Dimpfl, 2021), an additional step was added for states at risk of depleting their Bitcoin reserves during periods of RDF withdrawals. If the

prior day's Bitcoin balance minus the current day's withdrawal was insufficient to cover the transaction, sales were halted to prevent a negative balance. The aggregate market value of each portfolio component was calculated daily using current market prices for gold and Bitcoin. Total portfolio value was then adjusted to real terms using the CPI inflation index.

3. Results

3.1. Baseline scenario

The status quo model scenario allocates 100% of RDF flows to the EFFR (Figure 6). For context, a zero-investment 'do nothing' option was included, illustrating the total impact of CPI inflation on a one-time investment made on 01 January 2018. All other scenarios in Figure 6 assume a fixed 2% allocation to gold, with Bitcoin allocations varying between 0% and 10%.

To preserve the purchasing power of the initial investment, the CAGR (based on real returns) must exceed 0%. As shown in Figure 6, a portfolio allocation of 96% EFFR, 2% gold, and 2% Bitcoin barely breaks even in real terms, with a gain of 0.02%. Allocations of 3%, 5%, and 10% to Bitcoin generated positive real returns over the 7-year period, effectively preserving purchasing power and counteracting inflation.

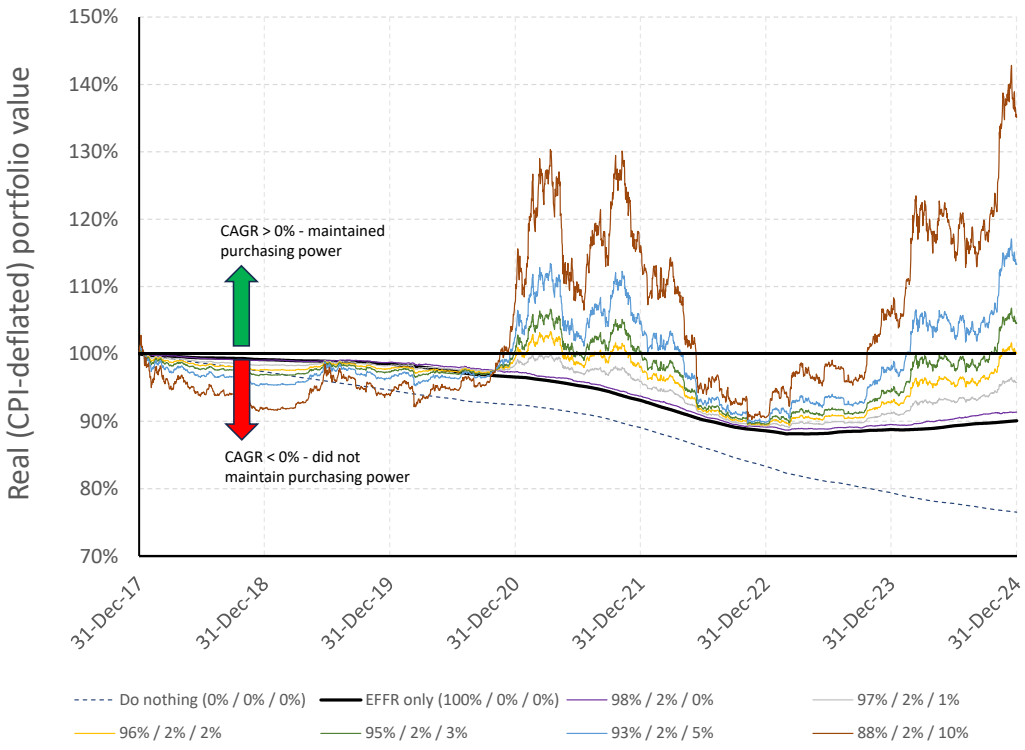

Figure 6: Real returns for various RDF investment allocation strategies for a one-time investment on 01 January 2018. Allocation percentages refer to the proportions of EFFR, gold, and Bitcoin investments, respectively.

Table 1 highlights the minimal asset combinations required to maintain purchasing power over the 7-year period for each Bitcoin allocation level. Bitcoin allocations of 3% or higher were sufficient on their own to offset inflation. Gold could also achieve this, but only at higher allocation levels (16%). Certain combinations, such as 1% Bitcoin with 9% gold or 2% Bitcoin with 2% gold, also produced positive CAGR. In contrast, a 100% treasury strategy yielded a CAGR of -1.48%, equating to a $992,004 loss in real purchasing power on a $10 million initial investment made on 01 January 2018.

Table 1: Minimal asset allocation combinations that, at a minimum, essentially offset the impacts of CPI inflation (real CAGR, 01 Jan 2018 to 31 Dec 2024).

	Asset combinations with CAGR > 0% with increasing allocations to Bitcoin					
Bitcoin	0%	1%	2%	3%	5%	10%
Gold	16%	9%	2%	0%	0%	0%
EFFR	84%	90%	96%	97%	95%	90%
CAGR	0.04%	0.003%	0.02%	0.45%	1.63%	4.25%

3.2. US states

Minnesota's results, representative of a mix of annual RDF flows (Figure 7), illustrate state-level outcomes. Over the 7-year analysis period, Minnesota experienced modest net RDF outflows in 2021 and 2023.

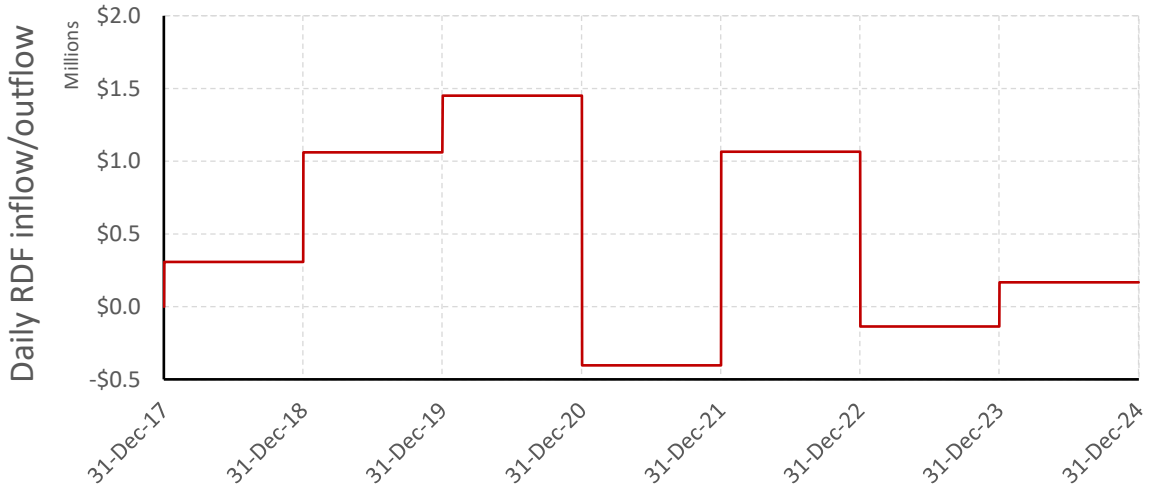

Figure 7: Minnesota RDF daily flows modeled from annual NASBO data on changes in RDF values by state.

The majority of Minnesota's RDF build-up occurred between 2018 and 2020, coinciding with Bitcoin's major bear market. This would have allowed the state to accumulate significant Bitcoin holdings at relatively low prices (Figure 8). As Bitcoin prices surged in 2023 and 2024, only minimal Bitcoin sales were required to meet RDF withdrawal needs, which are denominated in USD.

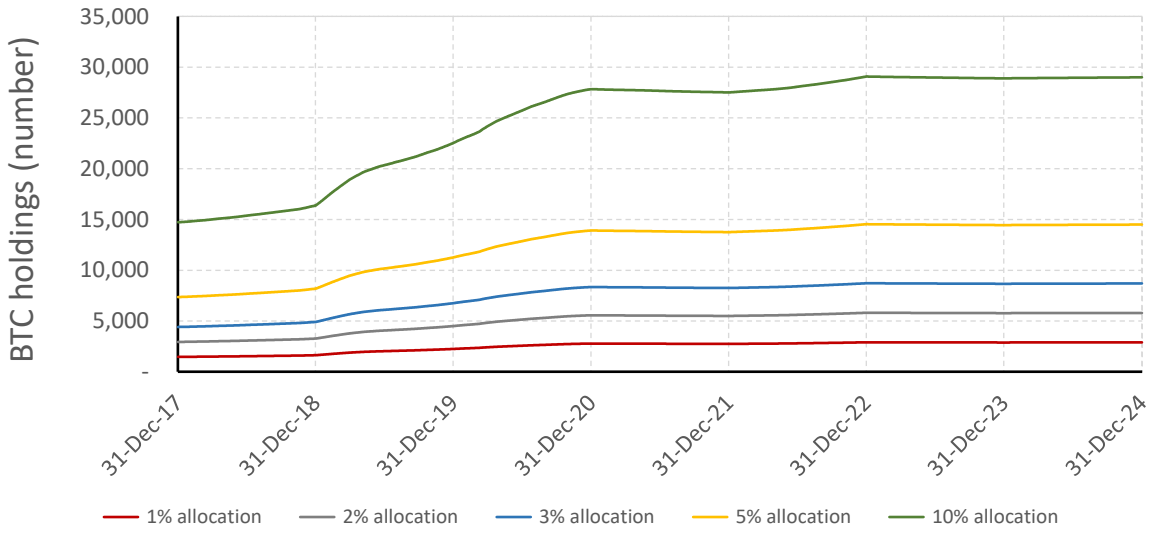

Figure 8: Bitcoin holdings in Minnesota's RDF under various Bitcoin allocation levels.

Figure 9 compares real (deflated) performance for four selected allocation strategies:

1. Baseline 100% EFFR.
2. 90% EFFR / 10% gold.
3. 90% EFFR / 5% gold / 5% Bitcoin.
4. 90% EFFR / 0% gold / 10% Bitcoin.

By 31 December 2024, the 100% EFFR-only baseline would have been valued at $2.89 billion (01 January 2018 dollars). In comparison, the 90% EFFR / 10% gold strategy yielded $3.07 billion, a 6.1% increase over the baseline. Portfolios allocating 5% and 10% to Bitcoin achieved real values of $3.87 billion and $4.66 billion, representing 33.6% and 61.1% increases over the baseline, respectively.

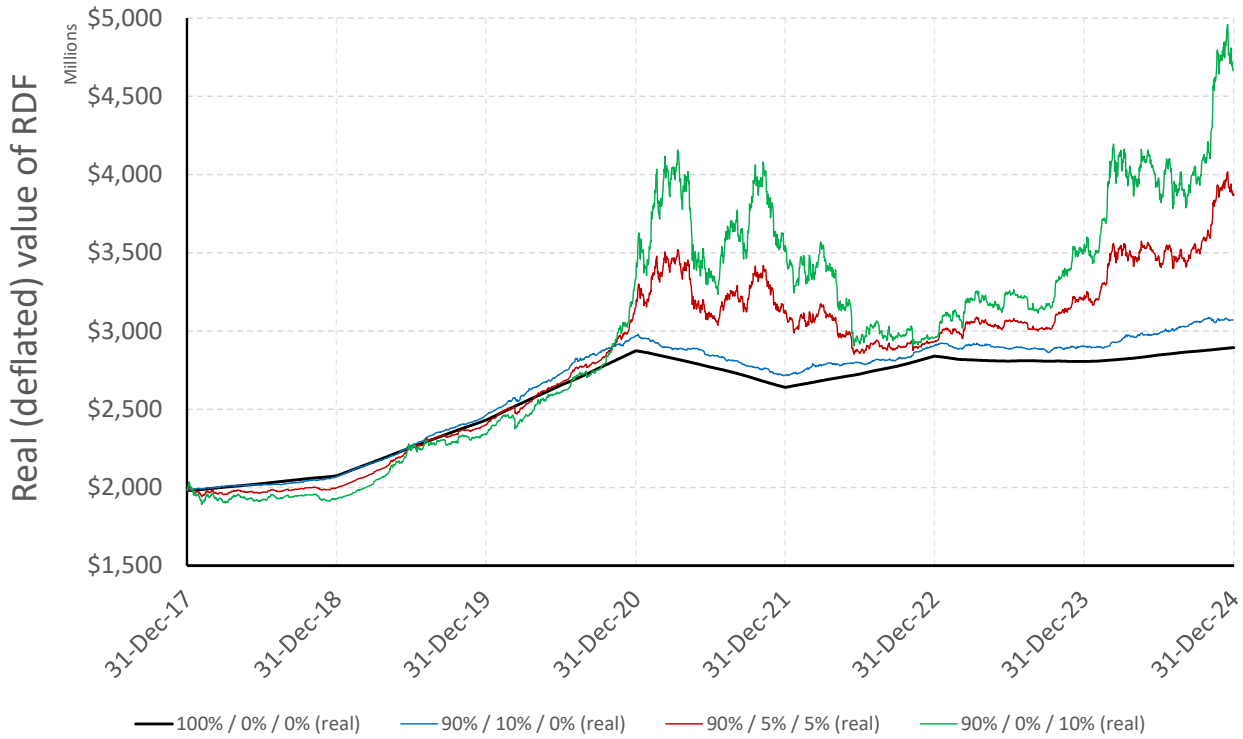

Figure 9: RDF real value (01 January 2018 dollars) for four portfolio allocation strategies.

In inflation-adjusted terms and relative to the baseline scenario of 100% EFFR allocation, the maximum drawdown for the gold-only allocations reached a maximum of 1% (August 2018) and as high as 9% for allocations with 10% Bitcoin. All combinations with Bitcoin, other than 10% gold and 1% Bitcoin, reached their levels of maximum drawdown in December, 2018.

Table 2 – Minnesota's maximum drawdowns and surpluses, based on real returns, for gold and Bitcoin allocation combinations/

	Maximum drawdown					
	Bitcoin = 0%	**Bitcoin = 1%**	**Bitcoin = 2%**	**Bitcoin = 3%**	**Bitcoin = 5%**	**Bitcoin = 10%**
Gold = 0%	0.0%	-0.8%	-1.5%	-2.3%	-4.0%	-8.2%
Gold = 1%	-0.1%	-0.8%	-1.6%	-2.4%	-4.0%	-8.3%
Gold = 2%	-0.2%	-0.9%	-1.7%	-2.5%	-4.1%	-8.4%
Gold = 3%	-0.3%	-1.0%	-1.7%	-2.5%	-4.2%	-8.5%
Gold = 5%	-0.5%	-1.1%	-1.9%	-2.7%	-4.3%	-8.6%
Gold = 10%	-1.0%	-1.6%	-2.2%	-3.0%	-4.6%	-9.0%
	Maximum surplus					
Gold = 0%	0.0%	6.7%	12.5%	17.7%	26.4%	41.7%
Gold = 1%	0.7%	7.2%	13.0%	18.1%	26.7%	41.9%
Gold = 2%	1.4%	7.8%	13.5%	18.5%	27.0%	42.1%
Gold = 3%	2.1%	8.3%	14.0%	19.0%	27.4%	42.4%
Gold = 5%	3.5%	9.4%	14.9%	19.8%	28.0%	42.8%
Gold = 10%	6.8%	12.0%	17.2%	21.8%	29.7%	43.8%

The highest return for gold relative to the EFFR-only baseline was 6.8% (recall that a 16% allocation to gold was needed to fully preserve purchasing power in the ‘do nothing’ baseline scenario); all gold-only allocations peaked in October, 2024. Combination allocations with any Bitcoin, even at 1%, performed similarly, with a minimum return of 6.7% for the 1% Bitcoin-only allocation; all combinations with any Bitcoin peaked in mid-December, 2024.

Table 3 presents state-specific percentage gains, in real dollar terms, of returns for a full range of additional scenarios relative to the 100% EFFR-only baseline. Bitcoin allocations of 3% delivered an average 13.3% increase in real value over the baseline by the end of the analysis period. Higher Bitcoin allocations of 5% and 10% delivered 22.2% and 44.4% average improvements in real return relative to baseline, respectively.

Table 3: Percent increase in overall real return relative to a 100% EFFR-only allocation by state and in aggregate for the period 01 January 2018 to 31 December 2024 (dollars normalized to 01 January 2018).

	Baseline scenario value, Dec 31, 2024 (millions)	**Allocation strategy**										
EFFR	100%	90%	95%	94%	93%	92%	90%	99%	98%	97%	95%	90%
Gold holdings	0%	10%	5%	5%	5%	5%	5%	0%	0%	0%	0%	0%
Bitcoin holdings	0%	0%	0%	1%	2%	3%	5%	1%	2%	3%	5%	10%
Alabama	$2,268.7	3.7%	1.9%	4.8%	7.8%	10.8%	16.8%	3.0%	6.0%	9.0%	14.9%	29.9%
Alaska	$2,312.6	1.2%	1.2%	2.5%	3.7%	5.0%	7.5%	1.2%	2.5%	3.7%	6.2%	12.5%
Arizona	$1,282.1	4.8%	2.4%	8.0%	13.6%	19.3%	30.5%	5.6%	11.3%	16.9%	28.1%	56.3%
Arkansas	$1,532.3	2.9%	1.5%	3.9%	6.3%	8.7%	13.6%	2.4%	4.8%	7.3%	12.1%	24.2%
California	$27,009.8	9.0%	4.5%	11.6%	18.6%	25.7%	39.8%	7.1%	14.1%	21.2%	35.3%	70.7%
Colorado	$1,712.4	6.3%	3.1%	9.8%	16.4%	23.0%	36.2%	6.6%	13.2%	19.9%	33.1%	66.2%
Connecticut	$3,531.9	5.1%	2.6%	10.5%	18.5%	26.5%	42.5%	8.0%	16.0%	23.9%	39.9%	79.8%
Delaware	$290.1	5.9%	3.0%	7.6%	12.3%	17.0%	26.4%	4.7%	9.4%	14.0%	23.4%	46.8%
Florida	$3,528.4	4.0%	2.0%	5.1%	8.1%	11.2%	17.4%	3.1%	6.2%	9.2%	15.4%	30.8%
Georgia	$4,797.0	5.1%	2.5%	6.0%	9.6%	13.1%	20.1%	3.5%	7.0%	10.5%	17.6%	35.1%
Hawaii	$1,256.1	3.1%	1.5%	2.7%	3.9%	5.1%	7.5%	1.2%	2.4%	3.6%	6.0%	12.0%
Idaho	$1,009.2	4.4%	2.2%	5.4%	8.6%	11.7%	18.1%	3.2%	6.4%	9.5%	15.9%	31.8%
Illinois	$1,754.0	2.5%	1.3%	3.3%	5.4%	7.4%	11.5%	2.1%	4.1%	6.2%	10.3%	20.5%
Indiana	$1,679.0	6.1%	3.1%	5.6%	8.2%	10.7%	15.9%	2.6%	5.1%	7.7%	12.8%	25.6%
Iowa	$847.0	6.0%	3.0%	8.4%	13.8%	19.2%	29.9%	5.4%	10.8%	16.2%	26.9%	53.9%
Kansas	$1,427.1	2.7%	1.3%	3.7%	6.1%	8.5%	13.3%	2.4%	4.8%	7.2%	12.0%	24.0%
Kentucky	$4,301.9	2.2%	1.1%	2.5%	4.0%	5.5%	8.4%	1.5%	2.9%	4.4%	7.3%	14.6%
Louisiana	$908.9	4.3%	2.2%	6.9%	11.6%	16.3%	25.7%	4.7%	9.4%	14.1%	23.5%	47.0%
Maine	$839.0	4.2%	2.1%	5.3%	8.4%	11.6%	18.0%	3.2%	6.3%	9.5%	15.9%	31.7%
Maryland	$2,104.2	4.7%	2.4%	7.0%	11.6%	16.2%	25.4%	4.6%	9.2%	13.8%	23.0%	46.1%
Massachusetts	$7,567.5	4.3%	2.2%	6.8%	11.5%	16.1%	25.4%	4.7%	9.3%	14.0%	23.3%	46.5%
Michigan	$1,731.9	5.1%	2.6%	6.4%	10.2%	14.0%	21.7%	3.8%	7.7%	11.5%	19.1%	38.3%
Minnesota	$2,894.0	6.1%	3.0%	9.2%	15.3%	21.4%	33.6%	6.1%	12.2%	18.3%	30.6%	61.1%
Mississippi	$553.1	5.1%	2.6%	8.1%	13.6%	19.2%	30.2%	5.5%	11.1%	16.6%	27.7%	55.3%
Missouri	$816.3	5.8%	2.9%	7.5%	12.0%	16.6%	25.7%	4.6%	9.1%	13.7%	22.8%	45.6%
Montana	$434.9	3.0%	1.5%	5.3%	9.1%	13.0%	20.6%	3.8%	7.6%	11.5%	19.1%	38.2%
Nebraska	$831.8	5.4%	2.7%	5.4%	8.0%	10.7%	16.0%	2.7%	5.3%	8.0%	13.3%	26.5%
Nevada	$1,044.6	3.5%	1.8%	4.1%	6.5%	8.9%	13.7%	2.4%	4.8%	7.1%	11.9%	23.8%

New Hampshire	$252.2	4.4%	2.2%	5.1%	7.9%	10.8%	16.5%	2.9%	5.7%	8.6%	14.3%	28.7%
New Jersey	$267.7	6.5%	3.3%	5.2%	7.1%	9.0%	12.8%	1.9%	3.8%	5.8%	9.6%	19.2%
New Mexico	$2,693.4	5.8%	2.9%	12.3%	21.7%	31.1%	49.8%	9.4%	18.8%	28.2%	46.9%	93.9%
New York	$5,359.4	4.1%	2.1%	5.8%	9.5%	13.2%	20.6%	3.7%	7.4%	11.1%	18.6%	37.1%
North Carolina	$4,103.5	4.4%	2.2%	4.5%	6.9%	9.2%	13.9%	2.3%	4.7%	7.0%	11.7%	23.3%
North Dakota	$784.7	5.3%	2.6%	11.5%	20.4%	29.3%	47.1%	8.9%	17.8%	26.7%	44.4%	88.8%
Ohio	$3,300.9	5.6%	2.8%	8.0%	13.2%	18.5%	28.9%	5.2%	10.4%	15.7%	26.1%	52.2%
Oklahoma	$1,721.4	4.1%	2.1%	5.8%	9.5%	13.2%	20.6%	3.7%	7.4%	11.1%	18.6%	37.2%
Oregon	$2,215.4	4.5%	2.3%	6.5%	10.7%	14.9%	23.4%	4.2%	8.4%	12.7%	21.1%	42.2%
Pennsylvania	$5,308.4	2.4%	1.2%	3.4%	5.6%	7.8%	12.3%	2.2%	4.4%	6.6%	11.1%	22.1%
Rhode Island	$241.6	6.0%	3.0%	4.8%	6.7%	8.5%	12.2%	1.8%	3.7%	5.5%	9.2%	18.3%
South Carolina	$1,037.3	5.8%	2.9%	9.7%	16.5%	23.3%	36.9%	6.8%	13.6%	20.4%	34.1%	68.1%
South Dakota	$216.7	6.0%	3.0%	7.3%	11.7%	16.0%	24.7%	4.3%	8.7%	13.0%	21.7%	43.4%
Tennessee	$1,769.8	4.5%	2.3%	6.7%	11.2%	15.6%	24.5%	4.5%	8.9%	13.4%	22.3%	44.6%
Texas	$17,409.2	4.4%	2.2%	4.8%	7.4%	10.0%	15.2%	2.6%	5.2%	7.8%	13.0%	25.9%
Utah	$1,045.0	5.4%	2.7%	7.6%	12.5%	17.3%	27.1%	4.9%	9.8%	14.7%	24.4%	48.8%
Vermont	$268.2	5.7%	2.9%	9.4%	15.9%	22.4%	35.4%	6.5%	13.0%	19.5%	32.5%	65.0%
Virginia	$4,166.5	3.0%	1.5%	4.3%	7.2%	10.0%	15.7%	2.8%	5.7%	8.5%	14.2%	28.3%
Washington	$1,571.6	7.1%	3.6%	10.5%	17.5%	24.4%	38.3%	7.0%	13.9%	20.9%	34.8%	69.5%
West Virginia	$1,087.0	5.1%	2.5%	6.8%	11.0%	15.2%	23.7%	4.2%	8.5%	12.7%	21.2%	42.3%
Wisconsin	$1,643.4	4.2%	2.1%	6.1%	10.1%	14.0%	22.0%	4.0%	8.0%	12.0%	19.9%	39.9%
Wyoming	$1,349.1	7.3%	3.6%	8.9%	14.2%	19.4%	30.0%	5.3%	10.5%	15.8%	26.3%	52.7%
Mean	**$2,761.6**	**5.3%**	**2.6%**	**7.1%**	**11.5%**	**16.0%**	**24.9%**	**4.4%**	**8.9%**	**13.3%**	**22.2%**	**44.4%**
Aggregate real value = $138.1 billion												

4. Discussion

Our findings suggest that integrating modest allocations of Bitcoin and gold into RDFs could significantly enhance their resilience against inflation and improve long-term real returns compared to traditional strategies reliant solely on interest-bearing, short-term investments. While Bitcoin's volatility presents unique risks, its positive skew and potential to hedge inflation at even small allocation levels (3% or higher) offers a compelling case for diversification (Ang et al., 2022; Brière et al., 2015). Gold, though less volatile, requires higher allocations to achieve similar results. By reevaluating investment frameworks and incorporating innovative asset strategies, state policymakers can better preserve the real value of RDFs, contributing to their ability to support critical services during economic downturns.

4.1. Implications of Inflation and Asset Allocation Strategies

4.1.1. Bitcoin as a High-Impact Allocator

Bitcoin emerged as a transformative asset within RDF portfolios. Even modest allocations of 2% to 10% significantly outperformed the baseline EFFR-only scenario, with average real return increasing from 8.9% at 2% allocation to 44.4% at 10%. Thirteen states would have seen real return increases exceeding the baseline by >50% at a 10% allocation level, highlighting Bitcoin's ability to protect purchasing power and deliver real RDF growth over the 2018-2024 time horizon. No strategy with any Bitcoin allocation performed at a lower level relative to the baseline EFFR-only scenario.

4.1.2. Gold's Moderate Role

Gold also played an important stabilizing role, with a 10% allocation improving aggregate real returns by 5.3% (but recall from Table 1 that a 16% allocation was needed to fully preserve purchasing power). While gold alone did not match Bitcoin's impact, its lower volatility made it a useful counterbalance in diversified portfolios. States with large RDF balances, such as Texas and California, saw incremental improvements when incorporating gold, though these gains were smaller than those achieved through Bitcoin-inclusive strategies. A 5% allocation to both gold and Bitcoin yielded average improvements in real yield of 24.9% from baseline, compared to 5.3% for a 10% allocation to a gold-only portfolio.

4.1.3. State-Specific Dynamics

State-level outcomes revealed significant variability driven by the timing of RDF cash flows relative to Bitcoin market cycles. States with steady inflows during bear markets and moderate outflows during bull markets benefited most from Bitcoin allocations. For example, New Mexico and North Dakota achieved real return improvements of 49.8% and 47.1%, respectively, with a 5% Bitcoin allocation. This success

stemmed from coincidental alignment, where inflows enabled accumulation at low prices and outflows occurred during peak market conditions.

Conversely, states with more volatile RDF dynamics, such as Alaska and Hawaii, saw smaller relative gains. High-volatility assets like Bitcoin require stable cash flow patterns to maximize their potential. The New Mexico example (Figure 10) demonstrates how timing—whether deliberate or coincidental—can substantially influence portfolio performance. By accumulating Bitcoin during bear markets and selling during bull markets, states with favorable cash flow timing reinforced Bitcoin's role as a high-impact allocator in diversified portfolios.

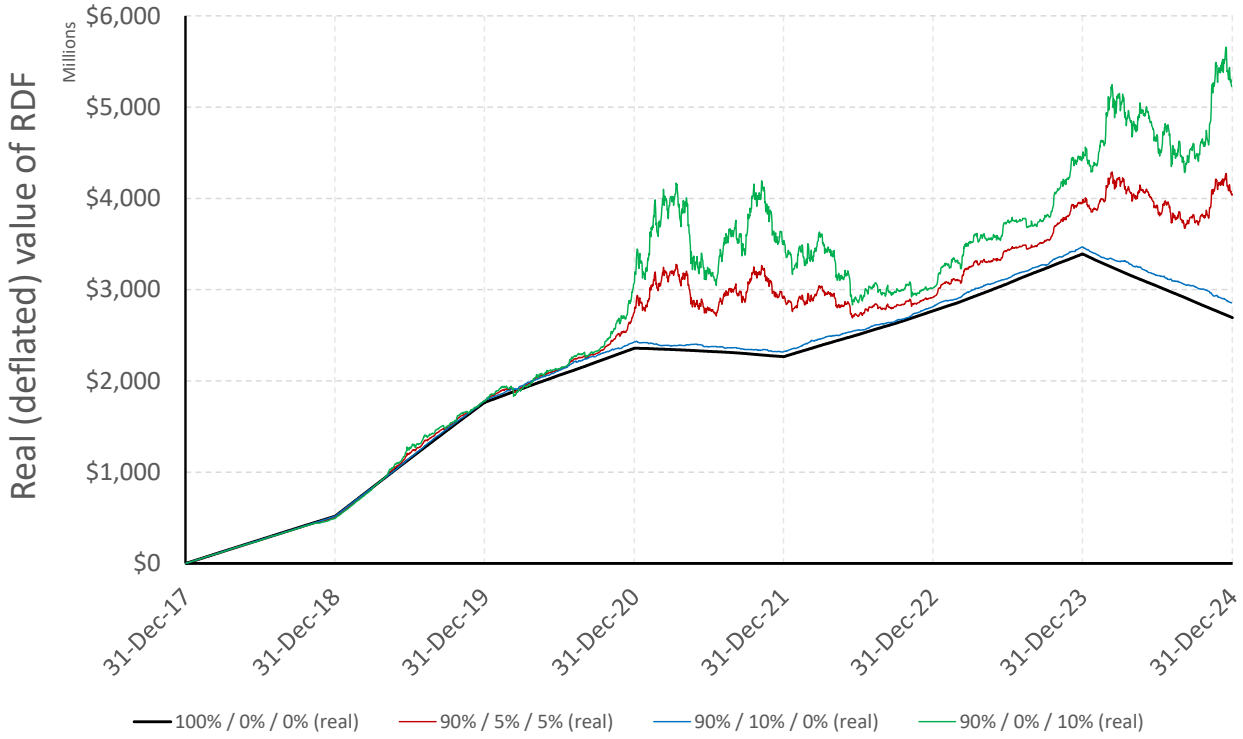

Figure 10: New Mexico returns with various portfolio allocations to Bitcoin and gold.

4.2. Future Research Needs

This study underscores the importance of exploring alternative asset allocations for state RDFs in the context of evolving economic conditions. While our current analysis highlights how Bitcoin and gold have historically mitigated inflation and enhanced RDF performance, future research could expand this framework by addressing broader measures of monetary debasement. Unlike CPI inflation, monetary debasement encompasses the erosion of currency value (Ruebling, 1975) due to prolonged monetary expansion and excess liquidity, manifesting in asset price inflation and diminished purchasing power over

time. Developing a robust methodology to quantify debasement could provide new insights into the effectiveness of alternative assets, such as Bitcoin and gold, as strategic hedges in RDFs.

Pre-Bitcoin research on optimal RDF allocations (Wagner and Elder, 2007) might also be updated given more recent advances in understanding Bitcoin's impact on optimal non-RDF portfolio allocations (e.g., Akhtaruzzaman et al., 2020; Ang et al., 2022; Brière et al., 2015; Henriques and Sadorsky, 2018).

Integrating historical performance analysis with a forward-looking Bitcoin price forecasts (Rudd and Porter, 2025) may also be useful. Grounding Bitcoin price trajectory predictions in economic fundamentals could facilitate the exploration of future RDF performance under varying assumptions about Bitcoin market conditions, adoption dynamics, and supply constraints. Such an approach may not only address concerns about Bitcoin's uncertain future performance but also enhance confidence in its role as an RDF investment.

4.3. Practical Implications for Policymakers

We provide actionable insights for state policymakers managing RDFs. Allocating modest proportions of portfolios to Bitcoin and gold offers a compelling opportunity to preserve purchasing power and achieve significant real returns, even with allocations as low as 3%. These strategies consistently outperformed the status quo while maintaining 24/7 year-round liquidity, demonstrating the potential for diversification to enhance RDF resilience.

By enabling RDFs to better withstand inflationary pressures, states may reduce the need for drastic fiscal measures during economic downturns, such as tax increases or spending cuts. This stability supports the continued provision of essential public services and fosters long-term economic resilience. Diversification into hard assets also signals innovative governance and forward-looking fiscal strategies, potentially influencing broader adoption of Bitcoin and gold as hedges against macroeconomic risks.

4.4. Challenges

To enable diversification into Bitcoin and gold, updates to state governance frameworks may be necessary. Many states currently face legal and regulatory barriers that prohibit investment in higher-growth or high-volatility assets, presenting significant obstacles to diversification. Revising these frameworks would require balancing political feasibility with stakeholder concerns, as well as incorporating robust oversight mechanisms and risk management protocols to address volatility while ensuring RDF stability. Policymakers must also navigate public perception, emphasizing the potential for increased fiscal sustainability and resilience through prudent diversification.

Managing Bitcoin's volatility is another critical challenge. High price fluctuations (Ang et al., 2022; Begušić et al., 2018) could lead to losses during periods of heavy RDF withdrawals, particularly for states with unstable cash flows. Gold provides a stabilizing counterbalance but lacks Bitcoin's inflation-hedging strength, necessitating careful consideration of trade-offs in allocation strategies. Additionally, disparities in RDF size and cash flow stability across states could create uneven benefits, underscoring the need for tailored solutions that reflect each state's unique fiscal circumstances. Any analyses of forward-looking portfolio allocations should include a range of performance metrics that help state personnel understand assess projected risk-adjusted returns.

5. Conclusion

Our case study underscores the potential for alternative asset allocations to transform RDF management. By integrating Bitcoin and gold into portfolio strategies, states can enhance their ability to preserve real value and maintain fiscal stability in the face of inflation and monetary expansion. While challenges related to volatility, regulatory constraints, and cash flow variability must be addressed, the potential benefits of diversification are substantial. Our findings provide a starting point for future research and pragmatic policy development for states seeking to modernize their RDF strategies and bolster financial resilience.

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