Minimum Effort, Maximum Savings:
Comparing Debt Repayment Strategy Performance

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This paper directly compares the real-world performance of three repayment strategies across varying debt types.

The total lifetime cost of a group of debts is determined by the borrower's repayment strategy. In this paper, we directly compare the performance of three strategies – AVALANCHE (manually prioritize high-interest debt), SNOWBALL (manually prioritize low-balance debt), and EPSILON (use optimal, fixed payment values) – across a variety of debt portfolios. Our results debunk the popular claim that AVALANCHE is universally the lowest-cost strategy accessible to borrowers. In fact, we provide an example for which AVALANCHE is the highest-cost strategy.

Introduction

The Problem

Of particular interest to borrowers is the problem of choosing a strategy that minimizes lifetime costs.

It's clear that debt due to credit cards, student loans, mortgages, installment loans, and other borrowing is both widespread and growing [1], [2], [3], [4], [5]. It's less clear how best to pay off this debt, assuming that it's financially possible to make more than the minimum payments. Of particular interest to borrowers is the problem of choosing a strategy that minimizes lifetime costs.

By and large, the mainstream assertion is that a strategy known as AVALANCHE is optimal. In this paper, we examine straightforward examples that prove this claim incorrect.

Debt Assumptions

We say that a debt is **analyzable** if it is both predictable and independent.

We assume that each debt under consideration is **analyzable**. This means that it is both **predictable** and **independent**.

- **Predictable** means that the debt's properties – remaining principal, interest rate, minimum payment, outstanding interest, forgiveness time, and next capitalization time – are known in advance.
- **Independent** means that these properties can be accessed for each debt separately, and that it is possible to direct specific payment values toward each debt individually.

Many common debt types are analyzable.

These assumptions cover many common debt types, with the notable exceptions of variable-rate loans, certain types of revolving credit accounts, and loans with certain types of income-based or graduated repayment plans (whose interest rates, balances, and minimum payments, respectively, are not known in advance).

Types of Analyzable Debts

For the sake of discussion, it is useful to consider two types of analyzable debts.

1. A **traditional** debt has a fixed interest rate, has no outstanding interest, and is not eligible for forgiveness.
2. A **non-traditional** debt may have any combination of (**i**) an interest rate that varies, (**ii**) outstanding interest (that may or may not capitalize), and (**iii**) forgiveness eligibility.

Performance Comparison

It's time to compare the performance of AVALANCHE, SNOWBALL, and EPSILON[†] using realistic, multi-loan examples.

Our comparison uses two measurements of performance.

1. The **savings** generated by each method give us a direct comparison of financial optimality. This is the most obvious way to measure performance.
2. The **effort** required to execute each method indicates the likelihood of perfect execution: the more effort required, the less likely the method is to be perfectly executed. We measure effort using the number of times that borrowers must manually re-calculate and change payment values during repayment.

While savings represent the theoretical performance of a strategy, effort tells us how likely the strategy is to succeed in practice.

Both measurements give us insight into the strategies considered in this paper. While savings represent the theoretical performance of a strategy, effort tells us how likely the strategy is to succeed in practice.

In each example that follows, we detail the properties of each loan involved, plus the total excess monthly payment to be distributed according to each of the three strategies. We then compare the resulting savings and required execution efforts.

Details of our methodology can be found at the end of this paper.

[†]See [6] for a detailed description of each strategy, including a discussion of benefits and drawbacks.

Example 1

First, we consider three traditional debts with the following properties.[†]

These loans might represent a combination of personal and installment loans.

	Balance ($)	Interest Rate (%)	Minimum Payment ($)
1	10,000	6.0	75
2	15,000	7.0	130
3	20,000	8.0	200
Total	45,000	–	405

Table 1: Properties of the three debts of Example 1.

Applying the three previous strategies to these debts – assuming a total monthly payment of $500 (or a total excess monthly payment of $95) – we find the results below. We compare these results to the benchmark MIN PMTS of paying only the minimum payments on all debts.

	Cost ($)	Savings ($)	Manual Changes
MIN PMTS	74,577	0	0
AVALANCHE	64,186	10,391	4
SNOWBALL	65,805	8,772	4
EPSILON	64,950	9,627	0

Table 2: Repayment results for the three debts of Example 1.

Here EPSILON delivers nearly 93% of the savings of a perfectly executed AVALANCHE, but requires no ongoing work to execute.

We see that AVALANCHE delivers the most savings, with SNOWBALL yielding just over 84% of the savings of AVALANCHE, and EPSILON yielding nearly 93% of the savings of AVALANCHE.

To execute AVALANCHE, though, four manual payment changes must be made (in months 91, 92, 116, and 117 of payoff); to execute SNOWBALL, the same number of manual changes must be made (this time in months 70, 71, 113, and 114). EPSILON, on the other hand, delivers its savings with no effort on the part of the borrower.

[†]Throughout this paper, all interest rates are annual interest rates.

Example 2

Next, we consider the six traditional debts below.

These debts might represent a combination of auto loans and student debt, serviced through different lenders.

	Balance ($)	Interest Rate (%)	Minimum Payment ($)
1	10,000	5.25	100
2	12,000	7.25	160
3	15,000	4.5	120
4	20,000	8.0	280
5	25,000	6.0	260
6	30,000	6.75	350
Total	112,000	–	1,270

Table 3: Properties of the six debts of Example 2.

Applying the three above methods to these debts – assuming a total monthly payment of $2,000 (or a total excess monthly payment of $730) – we find the results below. We again compare these results to the benchmark MIN PMTS.

	Cost ($)	Savings ($)	Manual Changes
MIN PMTS	151,967	0	0
AVALANCHE	131,848	20,119	10
SNOWBALL	133,886	18,081	10
EPSILON	133,337	18,630	0

Table 4: Repayment results for the six debts of Example 2.

EPSILON again performs well, even with more loans and more variance among their balances and interest rates.

AVALANCHE is again the most frugal strategy, with SNOWBALL delivering nearly 90% of its savings, and EPSILON yielding nearly 93% of its savings.

The manual changes for AVALANCHE take place in months 22, 23, 31, 32, 47, 48, 58, 59, 61, and 62 of repayment; the manual changes for SNOWBALL take place in months 13, 14, 24, 25, 37, 38, 47, 48, 58, and 59 of repayment. EPSILON, as always, requires no adjustment.

Example 3

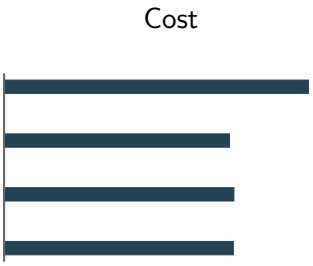
We now consider the twelve traditional loans below.

These loans could represent a combination of installment loans, student debt, auto loans, and a mortgage – all serviced through different lenders. The high number of loans makes a turnkey strategy especially attractive.

	Balance ($)	Interest Rate (%)	Minimum Payment ($)
1	10,000	4.25	75
2	10,000	4.5	80
3	12,000	4.5	100
4	12,000	4.75	110
5	15,000	6.25	175
6	15,000	6.5	200
7	20,000	8.0	275
8	25,000	4.25	175
9	30,000	6.5	350
10	35,000	8.5	500
11	45,000	5.5	375
12	200,000	6.0	1,200
Total	429,000	–	3,615

Table 5: Properties of the twelve debts of Example 3.

Below are the results for a monthly payment of $5,000 ($1,385 extra).



	Cost ($)	Savings ($)	Manual Changes
MIN PMTS	745,899	0	0
AVALANCHE	553,087	192,812	21
SNOWBALL	563,829	182,070	22
EPSILON	562,496	183,403	0

Table 6: Repayment results for the twelve debts of Example 3.

SNOWBALL achieves over 94% of AVALANCHE's savings; EPSILON achieves over 95%.

With a dozen loans, AVALANCHE and SNOWBALL each require nearly two dozen manual adjustments, spanning years across the repayment period. EPSILON still requires no adjustment.

Example 4

Next, we consider the two non-traditional debts below.

These debts might represent forgiveness-eligible student loans.

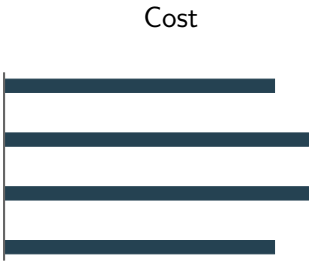
	Balance ($)	Interest Rate (%)	Minimum Payment ($)	Forgiveness Time (months)
1	10,000	6.0	100	104
2	10,000	3.0	100	104
Total	20,000	–	200	–

Table 7: Properties of the two debts of Example 4.

These debts are non-traditional because their balances are forgiven after a specified number of monthly payments.

Part 4(a)

First, we consider a total monthly payment of $225 ($25 extra).



	Cost ($)	Savings ($)	Manual Changes
MIN PMTS	20,800	0	0
AVALANCHE	23,400	−2,600	2
SNOWBALL	23,400	−2,600	2
EPSILON	20,800	0	0

Table 8: Repayment results for Example 4(a), total payment $225.

Ignoring loan forgiveness often leads to paying extra money toward loans that will be forgiven anyway.

These results may be surprising at first: how could MIN PMTS perform better than AVALANCHE and SNOWBALL? Simply put, these strategies do not account for loan forgiveness. This often leads to paying extra money toward loans that will be forgiven anyway, resulting in lower – or even negative – savings.

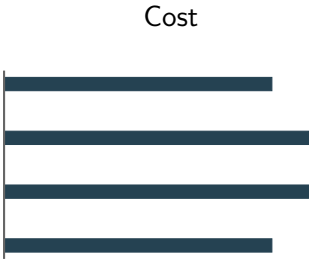
In this case, AVALANCHE and SNOWBALL not only require ongoing adjustments, but also cost the borrower thousands of dollars. This scenario is not uncommon when a borrower has debts with loan forgiveness.

EPSILON will never produce a cost higher than the forgiveness cost.

Note that EPSILON produces exactly the same cost as MIN PMTS; indeed, though the total monthly budget is $225, EPSILON automatically recognizes that this budget is not large enough to overcome the savings of forgiveness. It therefore assigns only the minimum payment to each debt.

Part 4(b)

We now consider a total monthly payment of $250 ($50 extra).



	Cost ($)	Savings ($)	Manual Changes
MIN PMTS	20,800	0	0
AVALANCHE	23,630	−2,830	2
SNOWBALL	23,630	−2,830	2
EPSILON	20,800	0	0

Table 9: Repayment results for Example 4(b), total payment $250.

In this case, AVALANCHE and SNOWBALL effectively throw money away.

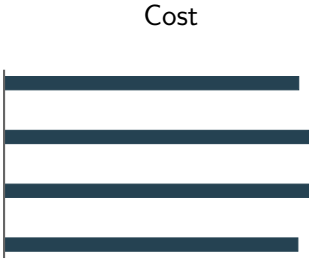
With a higher monthly payment, both AVALANCHE and SNOWBALL produce higher total costs: they use the increased payment to widen the gap between the total amount paid and the forgiveness cost.

EPSILON automatically accounts for forgiveness.

As before, EPSILON automatically detects this situation, assigning only the minimum payments to each debt.

Part 4(c)

Finally, we consider a total monthly payment of $500 ($300 extra).



	Cost ($)	Savings ($)	Manual Changes
MIN PMTS	20,800	0	0
AVALANCHE	21,484	−684	2
SNOWBALL	21,484	−684	2
EPSILON	20,739	61	0

Table 10: Repayment results for Example 4(c), total payment $500.

Though AVALANCHE and SNOWBALL have now improved, both strategies still cost the borrower money (while reducing cash flow and requiring ongoing changes).

It is sometimes possible to save more money on a loan when forgiveness is not exercised.

Notice that EPSILON has managed to find a way to save money beyond what is achievable through forgiveness alone. This illustrates an important idea: it is sometimes possible to save more money on a loan when forgiveness is not exercised. In other words, forgiveness is not always the most cost-effective strategy – each case must be analyzed separately. EPSILON does this comparison automatically.

Example 5

We now consider the eight non-traditional debts below.

	RP ($)	OI ($)	IR (%)	MP ($)	FT (months)	CT (months)
1	10,000	2,000	3.5	100	–	–
2	15,000	0	8.0	150	–	–
3	20,000	0	6.5	200	12	–
4	25,000	10,000	4.75	250	72	12
5	35,000	3,000	5.5	300	48	6
6	75,000	0	6.25	400	60	–
7	100,000	25,000	5.0	750	–	36
8	150,000	5,000	5.75	950	–	24
Total	430,000	45,000	–	3,100	–	–

Table 11: Properties of the eight debts of Example 5.

Table Abbreviations

RP	Remaining Principal
OI	Outstanding Interest
IR	Interest Rate
MP	Minimum Payment
FT	Forgiveness Time
CT	Capitalization Time

This set of debts is highly non-traditional.

In some sense, this collection of debts is highly non-traditional: it contains various combinations of outstanding interest, capitalization, and loan forgiveness.

Though we could analyze more complex cases (say, with changing interest rates known in advance), this example still illustrates the performance of the three strategies for a realistic set of non-traditional debts.

Part 5(a)

We first analyze a total payment of $4,000.

Cost

	Cost ($)	Savings ($)	Manual Changes
MIN PMTS	604,870	0	0
AVALANCHE	542,052	62,818	9
SNOWBALL	530,742	74,128	10
EPSILON	477,621	127,249	0

Table 12: Repayment results for Example 5(a), total payment $4,000.

In this scenario, AVALANCHE is the highest-cost strategy.

Interestingly, SNOWBALL yields a lower cost than AVALANCHE here, making AVALANCHE the highest-cost strategy. Since both strategies ignore the possibility of forgiveness, the financial effect of forgiveness can be thought of as being randomized across balance and interest rate. This means that each strategy has a chance of directing excess money toward a loan that is best handled with forgiveness. In this case, it turns out that prioritizing low balances has a less detrimental financial effect than prioritizing high interest rates.

EPSILON intelligently takes forgiveness into account.

As before, EPSILON intelligently takes forgiveness into account, ensuring that money is directed toward a loan with forgiveness only when that is a mathematically sound decision. The savings speak for themselves.

Part 5(b)

Last, we consider a total monthly payment of $4,500.

	Cost ($)	Savings ($)	Manual Changes
MIN PMTS	604,870	0	0
AVALANCHE	533,394	71,476	11
SNOWBALL	554,840	50,030	12
EPSILON	453,876	150,994	0

Table 13: Repayment results for Example 5(b), total payment $4,500.

EPSILON is carefully designed to never regress.

We see that AVALANCHE has improved its savings, while SNOWBALL has regressed considerably. This is particularly interesting, since using AVALANCHE with a total monthly payment of $4,500 still yields a higher cost than using SNOWBALL with a total monthly payment of just $4,000. This rather unintuitive result occurs because of the structure of this particular set of debts. In general, it is not possible to predict this behavior without a detailed analysis.

In this case, EPSILON achieves more savings than both AVALANCHE and SNOWBALL combined.

For this total monthly payment value, EPSILON delivers more savings than both AVALANCHE and SNOWBALL combined. Of note is that EPSILON is carefully designed to never regress in the way SNOWBALL did here: increasing a total monthly payment will never reduce the savings generated by EPSILON.

As always, EPSILON achieves these results with no manual adjustment of any kind.

Summary and Conclusions

Because the repayment strategy determines the cost of a set of loans, it is vital that borrowers choose their strategies wisely. To assist borrowers in comparing AVALANCHE, SNOWBALL, and EPSILON, we analyzed their costs, savings, and efforts for diverse groups of debts.

EPSILON combines optimal use of excess payments with set-and-forget execution.

We saw that AVALANCHE performed well for traditional debts, but ended up costing the borrower money for some non-traditional debt portfolios (even yielding the lowest savings, in some cases). SNOWBALL generally underperformed for traditional debts, but produced better savings than AVALANCHE for some non-traditional debt portfolios.

EPSILON's intelligent design prevents regression, overpaying with forgiveness, and other undesirable results.

EPSILON always achieved performance competitive with – if not ahead of – both AVALANCHE and SNOWBALL. In fact, EPSILON sometimes saved the borrower money while AVALANCHE and SNOWBALL ended up costing more than MIN PMTS. And because EPSILON uses fixed payment values, this performance was achieved automatically.

How to Obtain EPSILON Payment Values

We offer customized, straightforward, and informative PDF reports.

We use a proprietary algorithm to find optimal EPSILON payment values. EPSILON is capable of optimizing arbitrary combinations of traditional and non-traditional analyzable debts, including interest rate schedules (such as subsidized loans and introductory interest rates), loan forgiveness, outstanding interest, and interest capitalization.

Our customized, professional reports include EPSILON payment values and a number of financial metrics and visualizations, such as total savings, payoff times, ROI, ROR, and much more. Everything is packaged into a single, easy-to-read PDF, delivered securely.

Readers are encouraged to visit www.epsilonmetrics.com to learn more about the benefits of EPSILON, and to see example analyses.

A Word for Financial Professionals

EPSILON's turnkey nature and optimality make it an ideal solution for financial professionals seeking easy-to-implement, mathematically driven repayment plans.

This performance comparison is particularly relevant to financial professionals whose clients are borrowers: the flexibility, convenience, simplicity, and optimality of EPSILON make it an exceedingly practical choice.

Financial professionals are encouraged to read Mastering Client Debt Repayment: Ideal Repayment Plans for Clients and Advisors [7] to learn more about the fit between client, financial practice, and repayment plan.

About the Author

Nick Lorenzo holds a Ph.D. in Mathematics and an M.S. in Applied Mathematics from Rensselaer Polytechnic Institute and a B.S. in Mathematics and Physics from Case Western Reserve University. He is Epsilon's owner, founder, and lead mathematical researcher.

Methodology

We have used the 30/360 rule to calculate interest: each month, one-twelfth of a debt's annual interest rate is applied to its remaining principal, followed by the application of that debt's monthly payment (first to interest generated in the current month, then to outstanding interest, then to remaining principal). If outstanding interest capitalizes after t months, then, after t months, the outstanding interest is added to the remaining principal, then the monthly interest is applied, then the monthly payment is applied.

We assume that, if a debt is forgiven after t months, then, after t monthly payments are made (each meeting the minimum payment), the debt's remaining principal and outstanding interest both become zero.

AVALANCHE and SNOWBALL were applied using drop payments (to maximize savings).

We assume that all debts are analyzable, and that all currency is in USD.

For simplicity, we have ignored any secondary financial costs or benefits relating to a debt, such as tax and credit score implications. We also assume that the value of money is constant with respect to time.

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