The Good
The Bad And
The Ugly
Debt Analysts

- Tim Sabelko
- Jason Gilbert
- Ryan Erickson
- Matt Bach
- Jeff Mathes
What is Debt?

The idea of owing money to someone else.
Is Debt Good or Bad?

- How many have a debt?
- Consider good or bad?
Concepts Of Debt

- Good Debt
- Bad Debt
- Opportunity Costs
Good Debt vs. Bad Debt

- Good Debt Appreciates
- Bad Debt Depreciates
Good Debt

- Taking Out A Loan To Start A Business
- Taking Out A Loan For School
- Taking Out A Loan To Buy A House
Bad Debt

- Holding A Balance On A Credit Card
- Taking Out A Loan To Buy A New Car
- Taking Out A Loan To Go On A Trip
Opportunity Cost

- Time Spent In School
- Starting A Business
- Employee Training
Bad Debt: Credit Card Dynamics

- Model for Paying Credit Card Debt
- Analytic Solution
- Simulation
- Total Interest Paid
Analytic Solution

General Formula

\[ x(n + 1) = Rx(n) - P \]

where:

- \( P \) = payment
- \( R \) = Interest rate
- \( x(n) \) = balance at month \( n \)
Compartmental Diagram

\[ x(n + 1) - x(n) = rx(n) - p \]

\[ x(n + 1) = (1 + r)x(n) - P \]

\[ R = 1 + r \]

\[ x(n + 1) = Rx(n) - P \]
Analytic Solution

\[ x(n+1) = Rx(n) - P \]
\[ x(0) = x(0) \]
\[ x(1) = Rx(0) - P \]
\[ x(2) = Rx(1) - P \]
\[ = R[Rx(0) - P] - P \]
\[ = R^2 x(0) - RP - P \]
\[ = R^2 x(0) - P(R + 1) \]
Analytic Solution

\[ x(2) = R^2 x(0) - P(R + 1) \]

\[ x(3) = R x(2) - P \]
\[ = R [R^2 x(0) - P(R + 1)] - P \]
\[ = R^3 x(0) - RP(R + 1) - P \]
\[ = R^3 x(0) - P[R(R + 1) + 1] \]
\[ = R^3 x(0) - P(R^2 + R + 1) \]
Analytic Solution

\[x(3) = R^3 x(0) - P(R^2 + R + 1)\]

\[x(4) = Rx(3) - P\]
\[= R[R^3 x(0) - P(R^2 + R + 1)] - P\]
\[= R^4 x(0) - RP(R^2 + R + 1) - P\]
\[= R^4 x(0) - P[R(R^2 + R + 1) + 1]\]
\[= R^4 x(0) - P(R^3 + R^2 + R + 1)\]
Analytic Solution

Notice a pattern

\[ x(1) = Rx(0) - P \]
\[ x(2) = R^2 x(0) - P(R + 1) \]
\[ x(3) = R^3 x(0) - P(R^2 + R + 1) \]
\[ x(4) = R^4 x(0) - P(R^3 + R^2 + R + 1) \]
\[ x(n) = R^n x(0) - P(R^{n-1} + R^{n-2} + \ldots + R + 1) \]
Analytic Solution

\[ x(n) = R^n x(0) - P(R^{n-1} + R^{n-2} + ... + R + 1) \]

- This equation forms a Geometric Series
  \[ S = (R^{n-1} + R^{n-2} + ... + R + 1) \]

- This series can be simplified
Geometric Series

\[ S = R^{n-1} + R^{n-2} + \ldots + R + 1 \]

\[ RS = R^n + R^{n-1} + \ldots + R^2 + R \]

\[ 1 + RS = R^n + (R^{n-1} + \ldots + R^2 + R + 1) \]

\[ 1 + RS = R^n + S \]

\[ RS - S = R^n - 1 \]

\[ S(R - 1) = R^n - 1 \]

\[ S = \left( \frac{R^n - 1}{R - 1} \right), \quad R \neq 1 \]
Analytic Solution

Therefore our equation:

\[ x(n) = R^n x(0) - P(R^{n-1} + R^{n-2} + \ldots + R + 1) \]

can be written as

\[ x(n) = R^n x(0) - P \left( \frac{R^n - 1}{R - 1} \right), \quad R \neq 1 \]
Simulation

We ran simulations to show how long it would take to pay off your credit card bill.
Simulation 1

<table>
<thead>
<tr>
<th>Months</th>
<th>Balance</th>
<th>Interest</th>
<th>Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$3,000.00</td>
<td>$</td>
<td>$100.00</td>
</tr>
<tr>
<td>1</td>
<td>$2,945.00</td>
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<td>$1.70</td>
<td>$15.27</td>
</tr>
<tr>
<td>41</td>
<td>$</td>
<td>$</td>
<td>$</td>
</tr>
</tbody>
</table>

Total payment $4,015.27
Total interest $1,015.27
Effective interest rate 25.29%
Simulation 2

<table>
<thead>
<tr>
<th>Months</th>
<th>Balance</th>
<th>Interest</th>
<th>Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$4,000.00</td>
<td>-</td>
<td>$100.00</td>
</tr>
<tr>
<td>10</td>
<td>$1,000.00</td>
<td>$100.00</td>
<td>$100.00</td>
</tr>
<tr>
<td>20</td>
<td>$1,000.00</td>
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</tr>
<tr>
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<td>$100.00</td>
</tr>
<tr>
<td>40</td>
<td>$1,000.00</td>
<td>$100.00</td>
<td>$100.00</td>
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<tr>
<td>50</td>
<td>$1,000.00</td>
<td>$100.00</td>
<td>$100.00</td>
</tr>
<tr>
<td>60</td>
<td>$1,000.00</td>
<td>$100.00</td>
<td>$100.00</td>
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<tr>
<td>61</td>
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<td>$2.27</td>
<td>$53.69</td>
</tr>
<tr>
<td>62</td>
<td>-</td>
<td>-</td>
<td>-</td>
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**Total Payment**: $6,153.69  
**Total Interest**: $2,153.69  
**Effective Interest Rate**: 35.00%
Multiple Credit Cards

Optimizing Payments Within A Budget
Two Typical Credit Cards

<table>
<thead>
<tr>
<th>Card</th>
<th>Balance</th>
<th>Interest Rate</th>
<th>Funds</th>
</tr>
</thead>
<tbody>
<tr>
<td>VISA</td>
<td>3000</td>
<td>18%</td>
<td>X</td>
</tr>
<tr>
<td>Discover</td>
<td>5000</td>
<td>12%</td>
<td>Y</td>
</tr>
</tbody>
</table>

| Total Funds | 300 |

How do we pay off both cards?
The Equation

\[ b_1, b_2 = \text{the balances on both cards} \]
where \( b_1 = 3000, b_2 = 5000 \)
\[ r_1, r_2 = \text{the interest rates on both cards} \]
where \( r_1 = .18, r_2 = .12 \)
\[ F = \text{the available funds in your budget} \]
where \( F = 300 \)
\[ P = \text{interest charged next month} \]
\[ P = r_1(b_1 - x) + r_2(b_2 - y) \]
Minimizing the Interest

Question:

What is the most effective way to pay off the two credit card balances?

Answer:

Pay the card with the highest interest rate.
## Two Typical Credit Cards

<table>
<thead>
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<th>Funds</th>
</tr>
</thead>
<tbody>
<tr>
<td>VISA</td>
<td>$b_1$</td>
<td>$r_1$</td>
<td>X</td>
</tr>
<tr>
<td>Discover</td>
<td>$b_2$</td>
<td>$r_2$</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Total Funds</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Assumptions

- Your credit card company will not charge late fees.
- There will be no further charges made on your card.
Minimum Interest Equations

\[ y = F - x \]

\[ f(x) = r_1(b_1 - x) + r_2(b_2 - (F - x)) \]

\[ f(x) = r_1b_1 - r_1x + r_2b_2 - r_2F + r_2x \]

\[ f(x) = (r_2 - r_1)x + r_1b_1 + r_2(b_2 - F) \]
Finding Minimum Interest

\[ f(x) = (r_2 - r_1)x + r_1 b_1 + r_2 (b_2 - F) \]
Warning

Do not attempt this in the real world.

Why?

Your credit card company will charge you late fees in the real world.

Alternative:

Consolidate your credit cards with a home equity loan or low interest credit card.
Good Debt

Examples of Good Debt
✓ Education
✓ House
✓ Land

Example: We will use is taking a loan out for an Applied Math degree.
Assumptions

<table>
<thead>
<tr>
<th>Level Of Education</th>
<th>Median Salary</th>
<th>Debt Occurred</th>
</tr>
</thead>
<tbody>
<tr>
<td>High School</td>
<td>$26,000</td>
<td>$0.00</td>
</tr>
<tr>
<td>Associate degree</td>
<td>$31,500</td>
<td>$11,000</td>
</tr>
<tr>
<td>Math Related Degree</td>
<td>$55,000</td>
<td>$26,000</td>
</tr>
</tbody>
</table>
## Some Data

<table>
<thead>
<tr>
<th>Level Of Education</th>
<th>Time $n$ in Years</th>
<th>Income</th>
<th>Starting Debt</th>
</tr>
</thead>
<tbody>
<tr>
<td>High School</td>
<td>$0 &lt; n \leq 40$</td>
<td>2,166</td>
<td>0</td>
</tr>
<tr>
<td>Associate degree</td>
<td>$0 &lt; n \leq 2$</td>
<td>-458</td>
<td>0</td>
</tr>
<tr>
<td>Math Related Degree</td>
<td>$0 &lt; n \leq 4$</td>
<td>-542</td>
<td>0</td>
</tr>
<tr>
<td>Associate degree</td>
<td>$2 &lt; n \leq 40$</td>
<td>2,625</td>
<td>-11,000</td>
</tr>
<tr>
<td>Math Related Degree</td>
<td>$4 &lt; n \leq 40$</td>
<td>4,583</td>
<td>-26,000</td>
</tr>
</tbody>
</table>
After 108 months (5 years after you graduate)
Till retirement at age of 65
Your Math Degree Pays

- And 758,648 ahead of the associate degree grad.

- As you can see you come out 911,616 of the high school grad

- Well worth your 26,000 in loans.

<table>
<thead>
<tr>
<th>Month</th>
<th>High School</th>
<th>Math</th>
<th>Associate</th>
</tr>
</thead>
<tbody>
<tr>
<td>466</td>
<td>1009356</td>
<td>1887218</td>
<td>1155888</td>
</tr>
<tr>
<td>467</td>
<td>1011522</td>
<td>1891795</td>
<td>1158528</td>
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<tr>
<td>468</td>
<td>1013688</td>
<td>1896372</td>
<td>1161168</td>
</tr>
<tr>
<td>469</td>
<td>1015854</td>
<td>1900949</td>
<td>1163808</td>
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<tr>
<td>470</td>
<td>1018020</td>
<td>1905526</td>
<td>1166448</td>
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<td>1020186</td>
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<td>1169088</td>
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<tr>
<td>472</td>
<td>1022352</td>
<td>1914680</td>
<td>1171728</td>
</tr>
<tr>
<td>473</td>
<td>1024518</td>
<td>1919257</td>
<td>1174368</td>
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<td>474</td>
<td>1026684</td>
<td>1923834</td>
<td>1177008</td>
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<tr>
<td>475</td>
<td>1028850</td>
<td>1928411</td>
<td>1179648</td>
</tr>
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<td>476</td>
<td>1031016</td>
<td>1932988</td>
<td>1182288</td>
</tr>
<tr>
<td>477</td>
<td>1033182</td>
<td>1937565</td>
<td>1184928</td>
</tr>
<tr>
<td>478</td>
<td>1035348</td>
<td>1942142</td>
<td>1187568</td>
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<tr>
<td>479</td>
<td>1037514</td>
<td>1946719</td>
<td>1190208</td>
</tr>
<tr>
<td>480</td>
<td>1039680</td>
<td>1951296</td>
<td>1192848</td>
</tr>
</tbody>
</table>
Conclusions

✓ There is a right time to go into debt.

✓ Just think before you act.

✓ Do the Math.

✓ And make you good investments.
Summary

- Good Debt
- Bad Debt
- Opportunity Costs
References

- Bureau of the Census
- Bureau of Labor Statistics
- Dr. Deckelman
- Bill Kryshak CPA
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Opportunity Cost

- Time Spent In School
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Bad Debt: Credit Card Dynamics

- Model for Paying Credit Card Debt
- Analytic Solution
- Simulation
- Total Interest Paid
Analytic Solution

**General Formula**

\[ x(n + 1) = R x(n) - P \]

where:
- \( P = \) payment
- \( R = \) Interest rate
- \( x(n) = \) balance at month \( n \)
$x(n+1) - x(n) = rx(n) - p$

$x(n+1) = (1+r)x(n) - P$

$R = 1 + r$

$x(n+1) = Rx(n) - P$
Analytic Solution

\[ x(n + 1) = Rx(n) - P \]
\[ x(0) = x(0) \]
\[ x(1) = Rx(0) - P \]
\[ x(2) = Rx(1) - P \]
\[ = R[Rx(0) - P] - P \]
\[ = R^2 x(0) - RP - P \]
\[ = R^2 x(0) - P(R + 1) \]
Analytic Solution

\[ x(2) = R^2 x(0) - P(R + 1) \]

\[ x(3) = R x(2) - P \]
\[ = R[R^2 x(0) - P(R + 1)] - P \]
\[ = R^3 x(0) - RP(R + 1) - P \]
\[ = R^3 x(0) - P[R(R + 1) + 1] \]
\[ = R^3 x(0) - P(R^2 + R + 1) \]
Analytic Solution

\[ x(3) = R^3 x(0) - P(R^2 + R + 1) \]

\[ x(4) = Rx(3) - P \]
\[ = R[R^3 x(0) - P(R^2 + R + 1)] - P \]
\[ = R^4 x(0) - RP(R^2 + R + 1) - P \]
\[ = R^4 x(0) - P[R(R^2 + R + 1) + 1] \]
\[ = R^4 x(0) - P(R^3 + R^2 + R + 1) \]
Analytic Solution

Notice a pattern

\[ x(1) = Rx(0) - P \]
\[ x(2) = R^2 x(0) - P(R + 1) \]
\[ x(3) = R^3 x(0) - P(R^2 + R + 1) \]
\[ x(4) = R^4 x(0) - P(R^3 + R^2 + R + 1) \]
\[ x(n) = R^n x(0) - P(R^{n-1} + R^{n-2} + ... + R + 1) \]
Analytic Solution

\[ x(n) = R^n x(0) - P(R^{n-1} + R^{n-2} + \ldots + R + 1) \]

- This equation forms a Geometric Series
  \[ S = (R^{n-1} + R^{n-2} + \ldots + R + 1) \]

- This series can be simplified
Geometric Series

\[ S = R^{n-1} + R^{n-2} + \ldots + R + 1 \]

\[ RS = R^n + R^{n-1} + \ldots + R^2 + R \]

\[ 1 + RS = R^n + (R^{n-1} + \ldots + R^2 + R + 1) \]

\[ 1 + RS = R^n + S \]

\[ RS - S = R^n - 1 \]

\[ S(R - 1) = R^n - 1 \]

\[ S = \left( \frac{R^n - 1}{R - 1} \right), \quad R \neq 1 \]
Analytic Solution

Therefore our equation:

\[ x(n) = R^n x(0) - P(R^{n-1} + R^{n-2} + ... + R + 1) \]

can be written as

\[ x(n) = R^n x(0) - P \left( \frac{R^n - 1}{R - 1} \right), R \neq 1 \]
Simulation

We ran simulations to show how long it would take to pay off your credit card bill
### Simulation 1

<table>
<thead>
<tr>
<th>Months</th>
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<th>Interest</th>
<th>Payment</th>
</tr>
</thead>
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<tr>
<td>0</td>
<td>$3,000.00</td>
<td>$</td>
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<td>1</td>
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**Total Payment**: $4,015.27

**Total Interest**: $1,015.27

**Effective Interest Rate**: 25.29%
## Simulation 2

<table>
<thead>
<tr>
<th>Balance</th>
<th>$4,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearly interest</td>
<td>18%</td>
</tr>
<tr>
<td>Monthly payment</td>
<td>$100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Months</th>
<th>Balance</th>
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<tbody>
<tr>
<td>0</td>
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<td>-</td>
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</tr>
<tr>
<td>1</td>
<td>$3,000</td>
<td>$100.00</td>
<td>$100.00</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>60</td>
<td>$151.41</td>
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</tr>
<tr>
<td>61</td>
<td>$53.69</td>
<td>$2.27</td>
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**Effective Interest Rate**: 35.00%
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<td>Discover</td>
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<td>12%</td>
<td>Y</td>
</tr>
<tr>
<td><strong>Total Funds</strong></td>
<td><strong>300</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How do we pay off both cards?
The Equation

\[ P = r_1 (b_1 - x) + r_2 (b_2 - y) \]

\[ b_1, b_2 = \text{the balances on both cards} \]
where : \( b_1 = 3000, b_2 = 5000 \)

\[ r_1, r_2 = \text{the interest rates on both cards} \]
where : \( r_1 = .18, r_2 = .12 \)

\( F = \text{the available funds in your budget} \)
where : \( F = 300 \)

\( P = \text{interest charged next month} \)
Minimizing the Interest

Question:

What is the most effective way to pay off the two credit card balances?

Answer:

Pay the card with the highest interest rate.
# Two Typical Credit Cards

<table>
<thead>
<tr>
<th>Card</th>
<th>Balance</th>
<th>Interest Rate</th>
<th>Funds</th>
</tr>
</thead>
<tbody>
<tr>
<td>VISA</td>
<td>$b_1$</td>
<td>$r_1$</td>
<td>X</td>
</tr>
<tr>
<td>Discover</td>
<td>$b_2$</td>
<td>$r_2$</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td><strong>Total Funds</strong></td>
<td></td>
<td><strong>F</strong></td>
</tr>
</tbody>
</table>
Assumptions

• Your credit card company will not charge late fees.

• There will be no further charges made on your card.
Minimum Interest Equations

\[
y = F - x
\]

\[
f(x) = r_1 (b_1 - x) + r_2 (b_2 - (F - x))
\]

\[
f(x) = r_1 b_1 - r_1 x + r_2 b_2 - r_2 F + r_2 x
\]

\[
f(x) = (r_2 - r_1)x + r_1 b_1 + r_2 (b_2 - F)
\]
Finding Minimum Interest

\[ f(x) = (r_2 - r_1)x + r_1 b_1 + r_2 (b_2 - F) \]
Warning

Do not attempt this in the real world.

Why?

Your credit card company will charge you late fees in the real world.

Alternative:

Consolidate your credit cards with a home equity loan or low interest credit card.
Good Debt

Examples of Good Debt

✓ Education
✓ House
✓ Land

Example: We will use is taking a loan out for an Applied Math degree.
## Assumptions

<table>
<thead>
<tr>
<th>Level Of Education</th>
<th>Median Salary</th>
<th>Debt Occurred</th>
</tr>
</thead>
<tbody>
<tr>
<td>High School</td>
<td>$26,000</td>
<td>$0.00</td>
</tr>
<tr>
<td>Associate degree</td>
<td>$31,500</td>
<td>$11,000</td>
</tr>
<tr>
<td>Math Related Degree</td>
<td>$55,000</td>
<td>$26,000</td>
</tr>
</tbody>
</table>
## Some Data

<table>
<thead>
<tr>
<th>Level Of Education</th>
<th>Time $n$ in Years</th>
<th>Income</th>
<th>Starting Debt</th>
</tr>
</thead>
<tbody>
<tr>
<td>High School</td>
<td>$0 &lt; n \leq 40$</td>
<td>2,166</td>
<td>0</td>
</tr>
<tr>
<td>Associate degree</td>
<td>$0 &lt; n \leq 2$</td>
<td>-458</td>
<td>0</td>
</tr>
<tr>
<td>Math Related Degree</td>
<td>$0 &lt; n \leq 4$</td>
<td>-542</td>
<td>0</td>
</tr>
<tr>
<td>Associate degree</td>
<td>$2 &lt; n \leq 40$</td>
<td>2,625</td>
<td>-11,000</td>
</tr>
<tr>
<td>Math Related Degree</td>
<td>$4 &lt; n \leq 40$</td>
<td>4,583</td>
<td>-26,000</td>
</tr>
</tbody>
</table>
After 108 months (5 years after you graduate)
Till retirement at age of 65
### Your Math Degree Pays

<table>
<thead>
<tr>
<th>Month</th>
<th>High School</th>
<th>Math</th>
<th>Associate</th>
</tr>
</thead>
<tbody>
<tr>
<td>466</td>
<td>1009356</td>
<td>1887218</td>
<td>1155888</td>
</tr>
<tr>
<td>467</td>
<td>1011522</td>
<td>1891795</td>
<td>1158528</td>
</tr>
<tr>
<td>468</td>
<td>1013688</td>
<td>1896372</td>
<td>1161168</td>
</tr>
<tr>
<td>469</td>
<td>1015854</td>
<td>1900949</td>
<td>1163808</td>
</tr>
<tr>
<td>470</td>
<td>1018020</td>
<td>1905526</td>
<td>1166448</td>
</tr>
<tr>
<td>471</td>
<td>1020186</td>
<td>1910103</td>
<td>1169088</td>
</tr>
<tr>
<td>472</td>
<td>1022352</td>
<td>1914680</td>
<td>1171728</td>
</tr>
<tr>
<td>473</td>
<td>1024518</td>
<td>1919257</td>
<td>1174368</td>
</tr>
<tr>
<td>474</td>
<td>1026684</td>
<td>1923834</td>
<td>1177008</td>
</tr>
<tr>
<td>475</td>
<td>1028850</td>
<td>1928411</td>
<td>1179648</td>
</tr>
<tr>
<td>476</td>
<td>1031016</td>
<td>1932988</td>
<td>1182288</td>
</tr>
<tr>
<td>477</td>
<td>1033182</td>
<td>1937565</td>
<td>1184928</td>
</tr>
<tr>
<td>478</td>
<td>1035348</td>
<td>1942142</td>
<td>1187568</td>
</tr>
<tr>
<td>479</td>
<td>1037514</td>
<td>1946719</td>
<td>1190208</td>
</tr>
<tr>
<td>480</td>
<td>1039680</td>
<td>1951296</td>
<td>1192848</td>
</tr>
</tbody>
</table>

- And 758,648 ahead of the associate degree grad.
- As you can see you come out 911,616 of the high school grad
- Well worth your 26,000 in loans.
Conclusions

✓ There is a right time to go into debt.

✓ Just think before you act.

✓ Do the Math.

✓ And make you good investments.
Summary

- Good Debt
- Bad Debt
- Opportunity Costs
References

- Bureau of the Census
- Bureau of Labor Statistics
- Dr. Deckelman
- Bill Kryshak CPA