EC3101: MICROECONOMIC ANALYSIS II

Instructor: Timothy Wong

Contact Information

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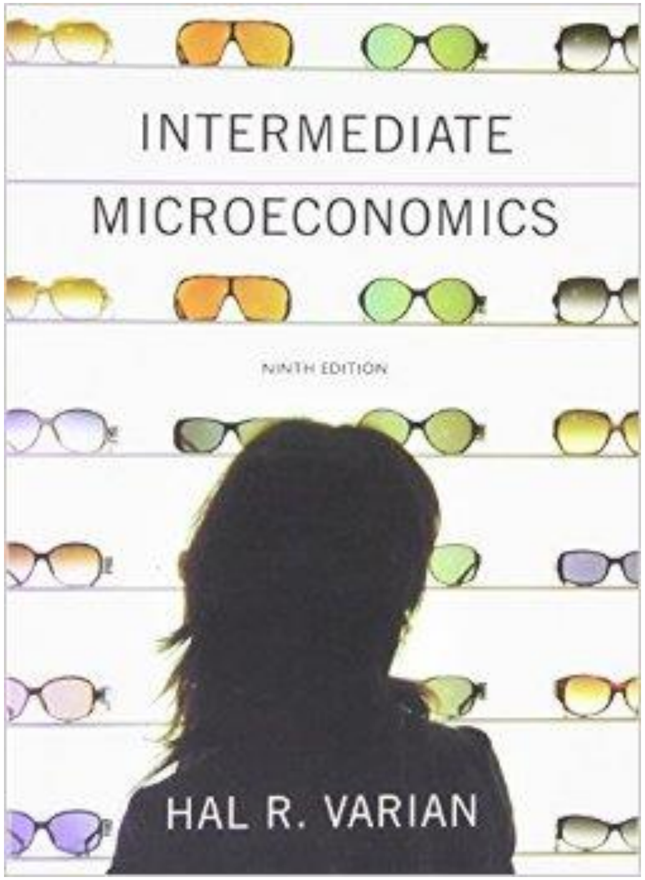
Office location: AS2-04-28

Office hours: Tuesdays, 1pm to 3pm

Textbook



- Intermediate Microeconomics (ninth edition) by Hal R. Varian

Syllabus

Week 1 (Aug 11)	**Course Overview; Intertemporal Choice, Ch.10**
Week 2 (Aug 18)	Uncertainty, Ch. 12
Week 3 (Aug 25)	Exchange, Ch.32
Week 4 (Sept 1)	Monopoly, Ch.25
Week 5 (Sept 8)	Monopoly, Ch.25; Oligopoly, Ch.28
Week 6 (Sept 15)	Oligopoly, Ch.28
Recess Week	
Week 7 (Sept 29)	Midterm
Week 8 (Oct 6)	Game Theory, Ch.29
Week 9 (Oct 13)	Game Theory, Ch.29, Game Applications, Ch. 30
Week 10 (Oct 20)	Game Applications, Ch. 30
Week 11 (Oct 27)	Externalities, Ch. 35, Public Goods, Ch. 37 [Homework 2 due on Oct 30 at 6pm]
Week 12 (Nov 2)	Asymmetric Information, Ch. 38
Week 13 (Nov 9)	Review [webcast lecture in lieu of Deepavali holiday]

Assessment

• Homework	10%
• Participation	10%
• Midterm Exam	30%
• Final Exam	50%

Homework

- Two individual problem sets
- Will be posted to IVLE one week before
  - Problem set I will be posted 6 pm, Sept 4th
  - Problem set II will be posted 6 pm, Oct 23rd
- Please submit hard copy to tutor's mailbox
  - Problem set I is due 6 pm, September 11th
  - Problem set II is due 6 pm, October 30th

Homework

- 25% of total possible points deducted for every day the submission is late

Participation

- Practice problems will be posted to IVLE every Monday, beginning in week 2.
- These problems will be discussed in tutorials the following week
  - Problems posted in week 2 will be discussed in week 3
- Students will be randomly selected to present the solutions each week.
- Every student has to present at least once during the semester.

Participation

- To obtain a good participation grade, students must present with clarity.
- While correct answers will be rewarded, wrong answers will not be severely penalized as long as the student demonstrates good effort and logic in explaining his/her solution.

Participation

- Midterm
  - Worth 30% of your final grade
  - September 29th, 8 a.m. to 10 a.m.
- Final
  - Worth 50% of your final grade
  - November 30th, 1 p.m. to 3 p.m.
- Both exams are closed-book

Other Information

- Attendance at tutorials will be recorded and students who miss two tutorials will be reported to the Dean's office. This is a faculty policy
- Academic dishonesty is unacceptable. Any suspected cases of dishonesty will be reported and handled according to university policy.

Other Information

- Content taught in this course builds on material from previous courses, in particular, EC2101. To help you succeed in this class I advice that you review your notes on
  - Consumer theory
  - Production theory
  - Competitive markets

Other Information

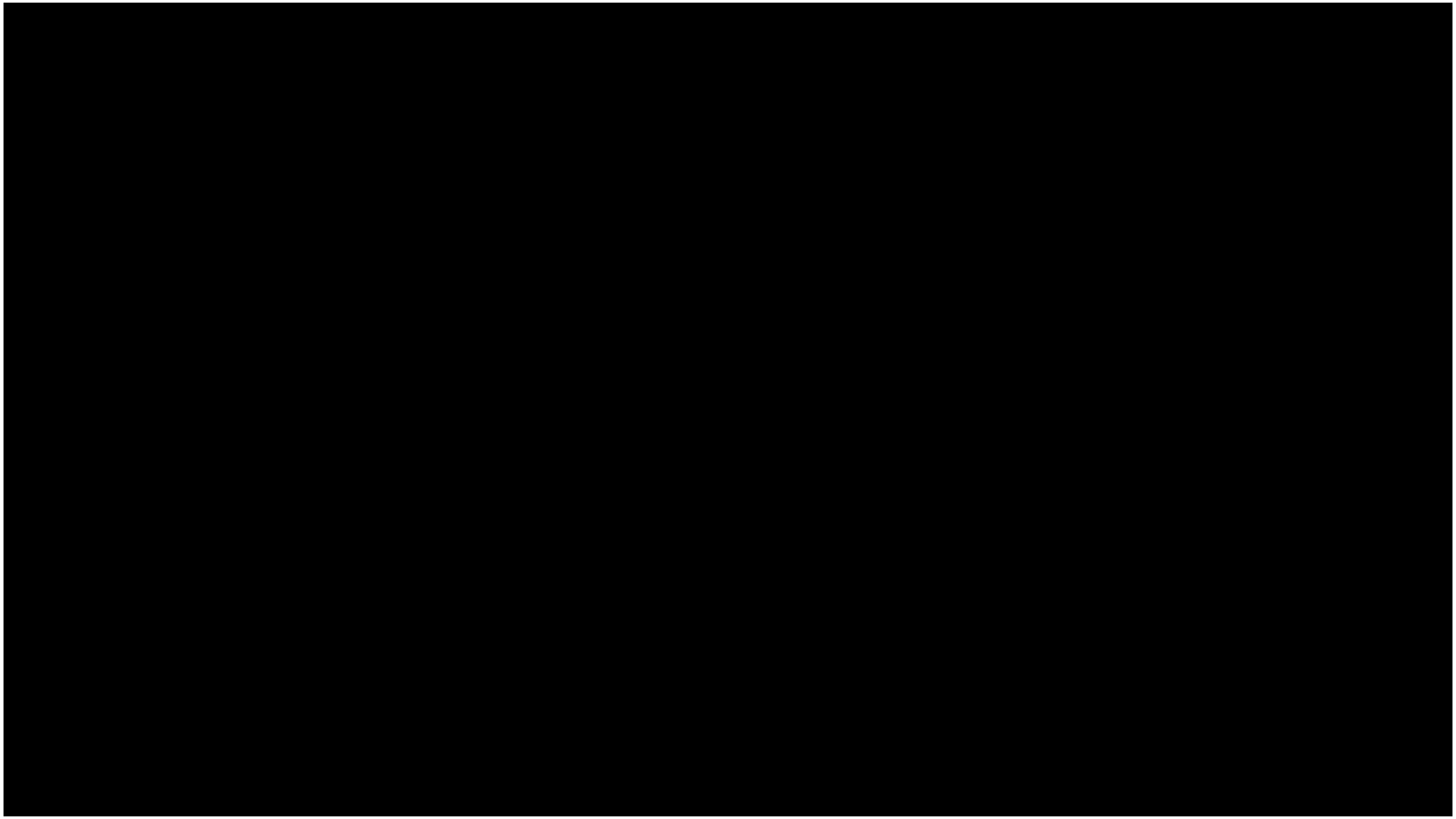
- Lectures will be webcasted. Videos will be posted on IVLE.

CHAPTER TEN: INTERTEMPORAL CHOICE

Intertemporal Choice

- Persons often receive income in "lumps"; *e.g.* monthly salary.
- How is a lump of income spread over the following month (saving now for consumption later)?
- Or how is consumption financed by borrowing now against income to be received at the end of the month?

Intertemporal Choice



https://www.youtube.com/watch?v=QX_oy9614HQ

Present and Future Value

How do we value current goods in the future (future value) and future goods in the present (present value)

Present and Future Values

Present Value (PV)

Future Value (FV)

- Begin with some simple financial arithmetic.
- Take just two periods; 1 and 2.
- Let r denote the interest rate per period.

Future Value

- E.g., if r = 0.1 then \$100 saved at the start of period 1 becomes \$110 at the start of period 2.
- The value next period of \$1 saved now is the future value of that dollar.

Future Value

- Given an interest rate r the future value one period from now of $1 is:

$$FV = 1+r$$

- Given an interest rate r the future value one period from now of $m is:

$$FV = m(1+r)$$

Present Value

- Suppose you can pay someone an amount of money now to obtain \$1 at the start of next period. What is the most you should pay? \$1?
- No. If you kept your \$1 now and saved it then at the start of next period you would have $\$(1+r) > \$1$, so paying \$1 now for \$1 next period is a bad deal.
- The most you should pay is less than \$1

Present Value

- How much money would have to be saved now, in the present, to obtain \$1 at the start of the next period?
- \$m saved now becomes \$m(1+r) at the start of next period, so we want the value of m for which

  $$m(1+r) = 1$$

  That is, $m = 1/(1+r)$,

  the present-value of \$1 obtained at the start of next period.

Present Value

- The present value (PV) of \$1 available at the start of the next period is

$$PV = \frac{1}{1+r}$$

- And the present value of \$m available at the start of the next period is

$$PV = \frac{m}{1+r}$$

Present Value

- E.g., if r = 0.1 then the most you should pay now for $1 available next period is

$$\mathrm{PV} = \frac{1}{1 + 0.1} = \$0.91$$

- And if r = 0.2 then the most you should pay now for $1 available next period is

$$\mathrm{PV} = \frac{1}{1 + 0.2} = \$0.83$$

Present Value

- When r = 0.1, PV = \$0.91
- When r = 0.2, PV = \$0.83
- Notice that the present value is higher when the interest rate is lower, and vice versa
- The interest rate is **the cost of borrowing/lending.** The higher the cost of borrowing, the less \$1 is worth in the present.

The Intertemporal Choice Problem

Modeling how individuals decide whether to consume now or later?

The Intertemporal Choice Problem

- Let m_1 and m_2 be incomes received in periods 1 and 2.
- Let c_1 and c_2 be consumptions in periods 1 and 2.
- Let p_1 and p_2 be the prices of consumption in periods 1 and 2.

The Intertemporal Choice Problem

- The intertemporal choice problem: Given incomes m_1 and m_2, and consumption prices p_1 and p_2, what is the most preferred intertemporal consumption bundle (c_1, c_2)?
- For an answer we need to know:
  - the intertemporal budget constraint
  - intertemporal consumption preferences.

The Intertemporal Budget Constraint

- To start, let's ignore price effects by supposing that

$$p_1 = p_2 = \$1.$$

The Intertemporal Budget Constraint

- Suppose that the consumer chooses not to save or to borrow.

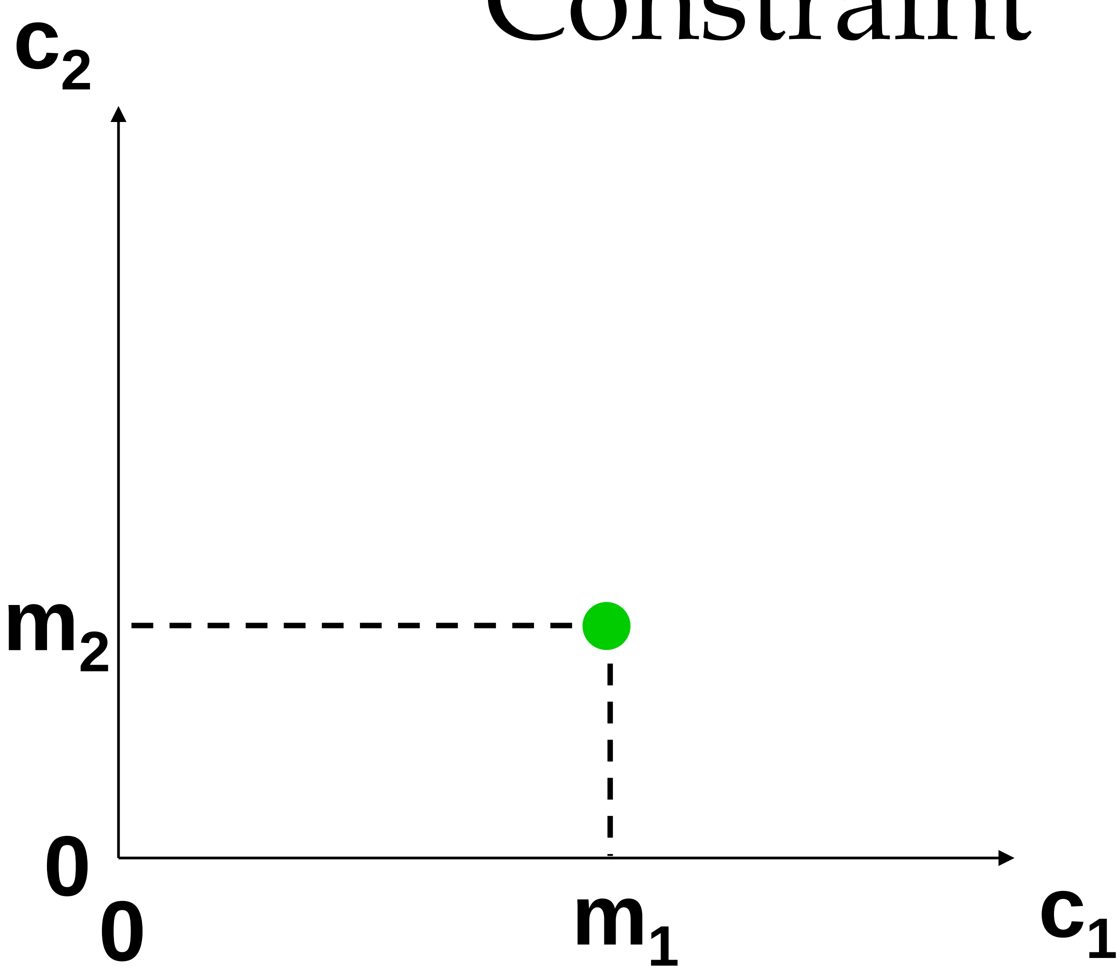
Q: What will be consumed in period 1?

A: $c_1 = m_1$.

Q: What will be consumed in period 2?

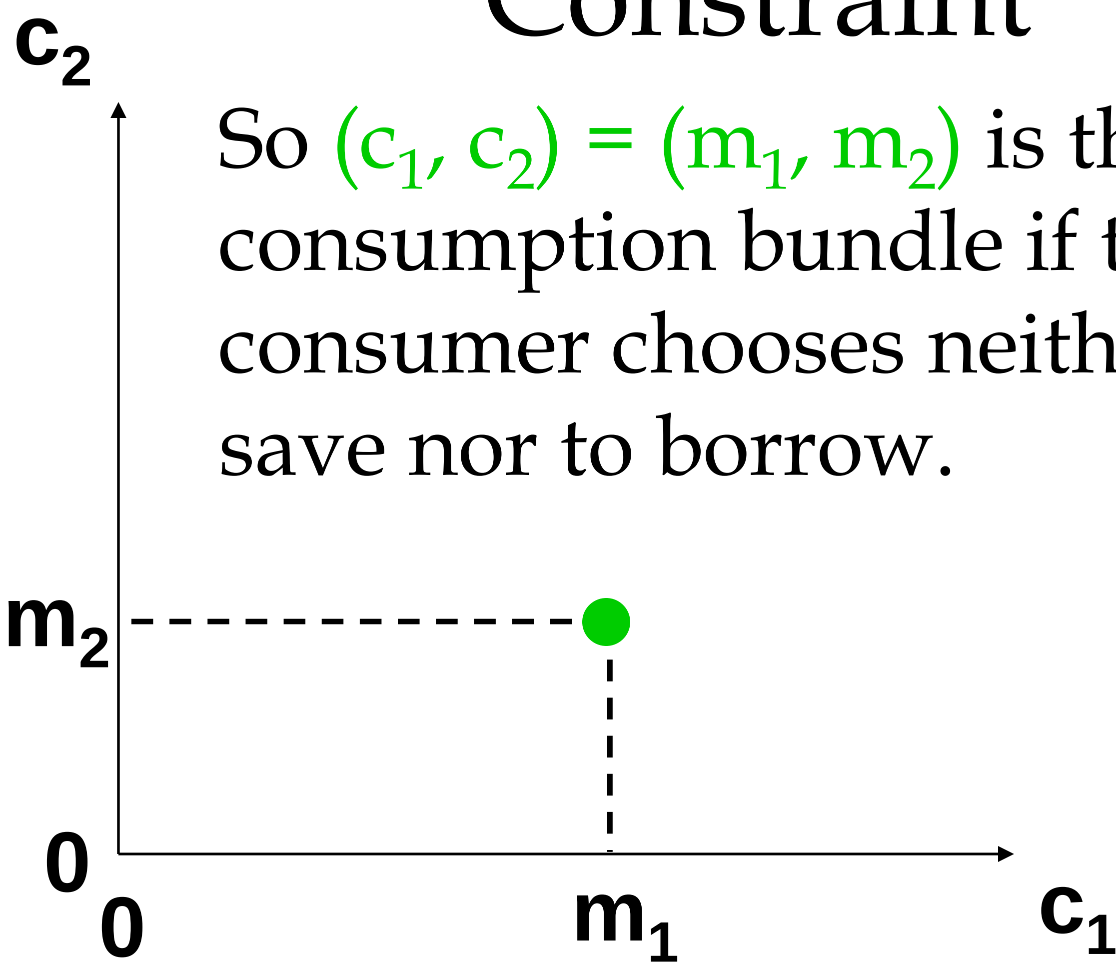
A: $c_2 = m_2$.

The Intertemporal Budget Constraint



The Intertemporal Budget Constraint

So $(c_1, c_2) = (m_1, m_2)$ is the consumption bundle if the consumer chooses neither to save nor to borrow.



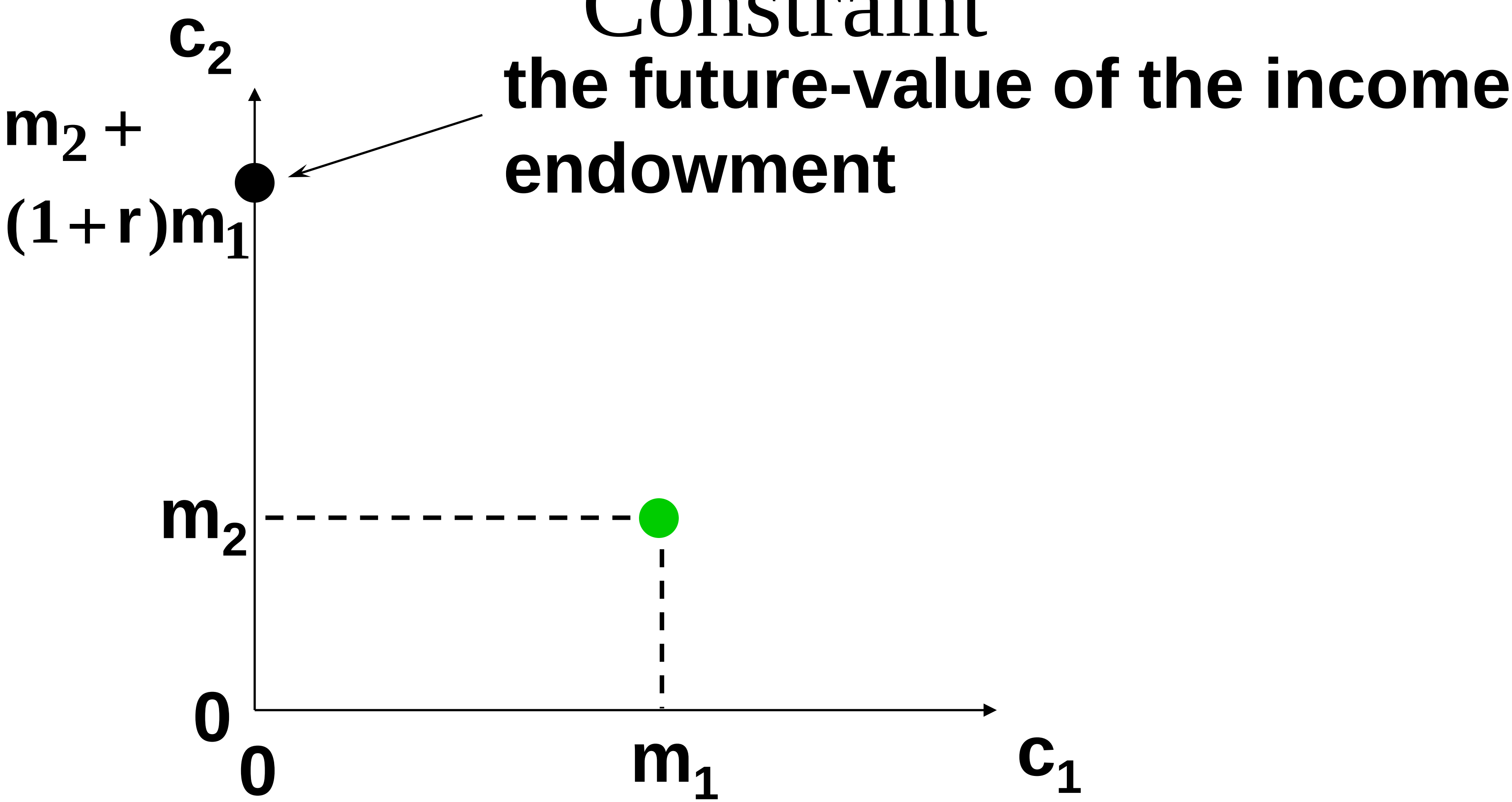
The Intertemporal Budget Constraint

- Now suppose that the consumer spends nothing on consumption in period 1; that is, $c_1 = 0$ and the consumer saves
  $$s_1 = m_1.$$
- The interest rate is r.
- What now will be period 2's consumption level?

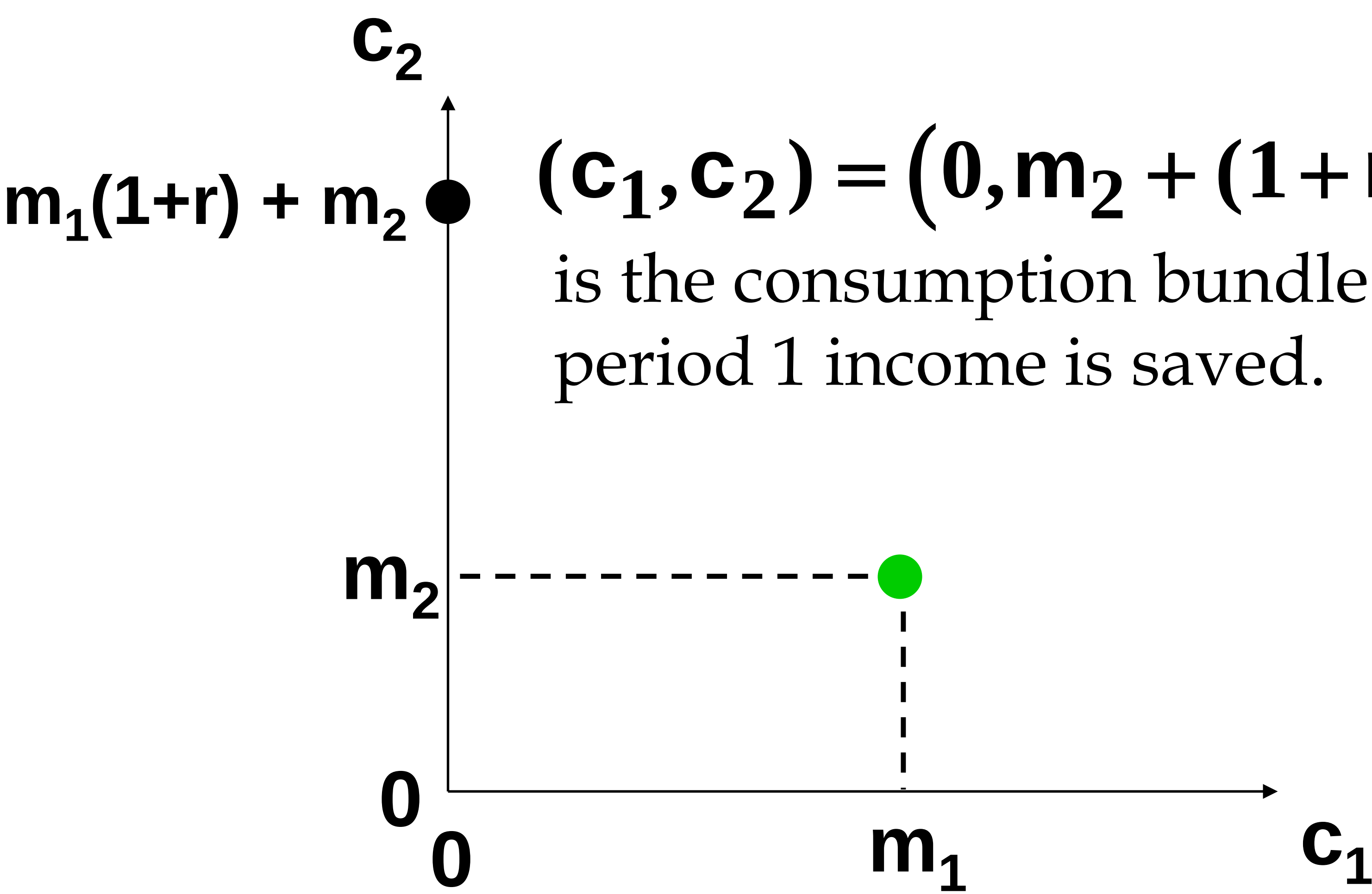
The Intertemporal Budget Constraint

- Period 2 income is m_2.
- Savings plus interest from period 1 sum to $(1 + r)m_1$.
- So total income available in period 2 is
$$m_2 + (1 + r)m_1.$$
- So period 2 consumption expenditure is
$$c_2 = m_2 + (1+r)m_1$$

The Intertemporal Budget Constraint



The Intertemporal Budget Constraint



$$(c_1, c_2) = \left(0, m_2 + (1+r)m_1\right)$$

is the consumption bundle when all period 1 income is saved.

The Intertemporal Budget Constraint

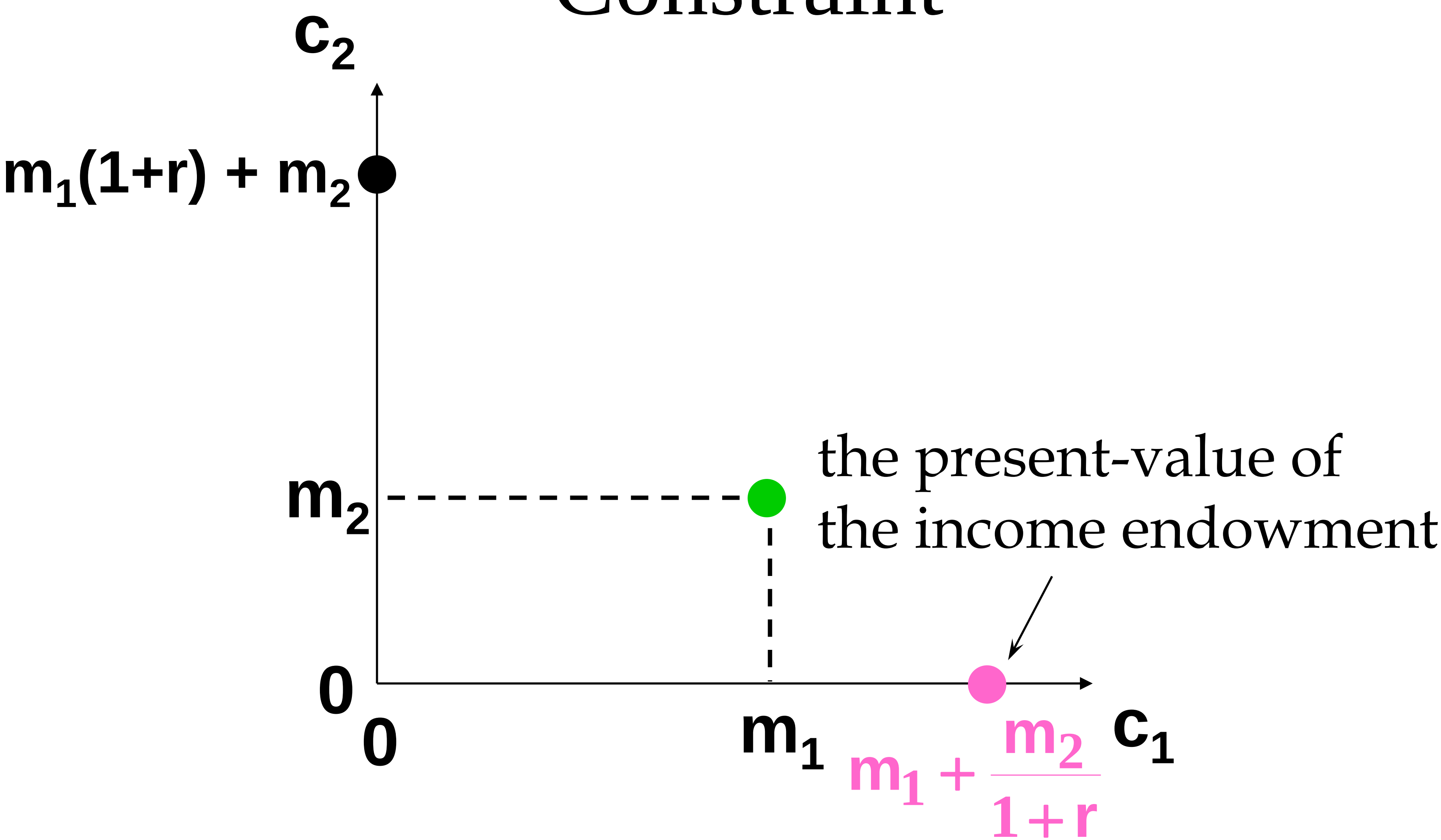
- Now suppose that the consumer spends everything possible on consumption in period 1, so $c_2 = 0$.
- What is the most that the consumer can borrow in period 1 against her period 2 income of $\$m_2$?
- Let b_1 denote the amount borrowed in period 1.

The Intertemporal Budget Constraint

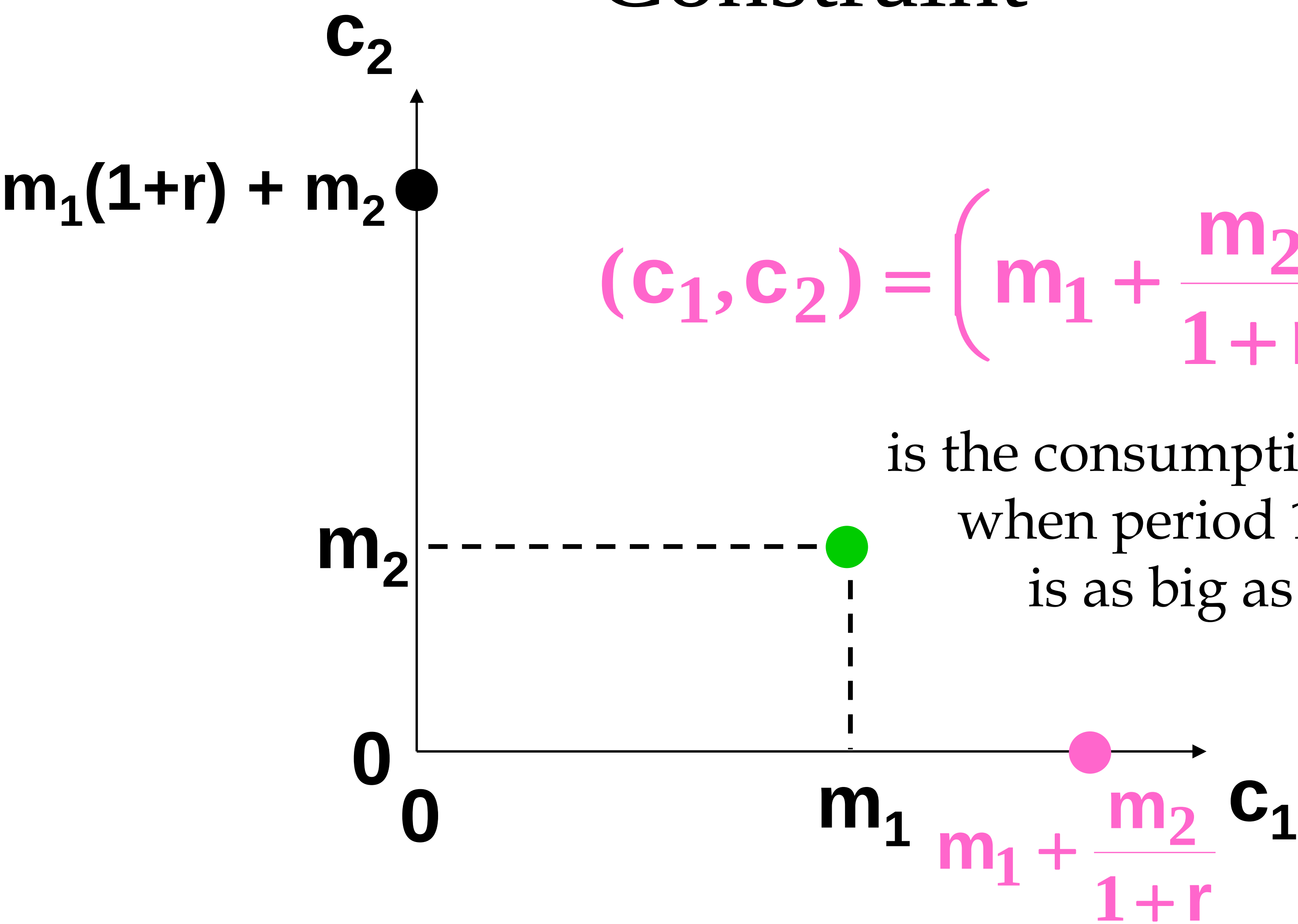
- Only \$$m_2$ will be available in period 2 to pay back \$$b_1$ borrowed in period 1.
- So $b_1(1 + r) = m_2$.
- That is, $b_1 = m_2 / (1 + r)$.
- So the largest possible period 1 consumption level is

$$c_1 = m_1 + \frac{m_2}{1+r}$$

The Intertemporal Budget Constraint



The Intertemporal Budget Constraint



$$(c_1, c_2) = \left(m_1 + \frac{m_2}{1+r}, 0\right)$$

is the consumption bundle when period 1 borrowing is as big as possible.

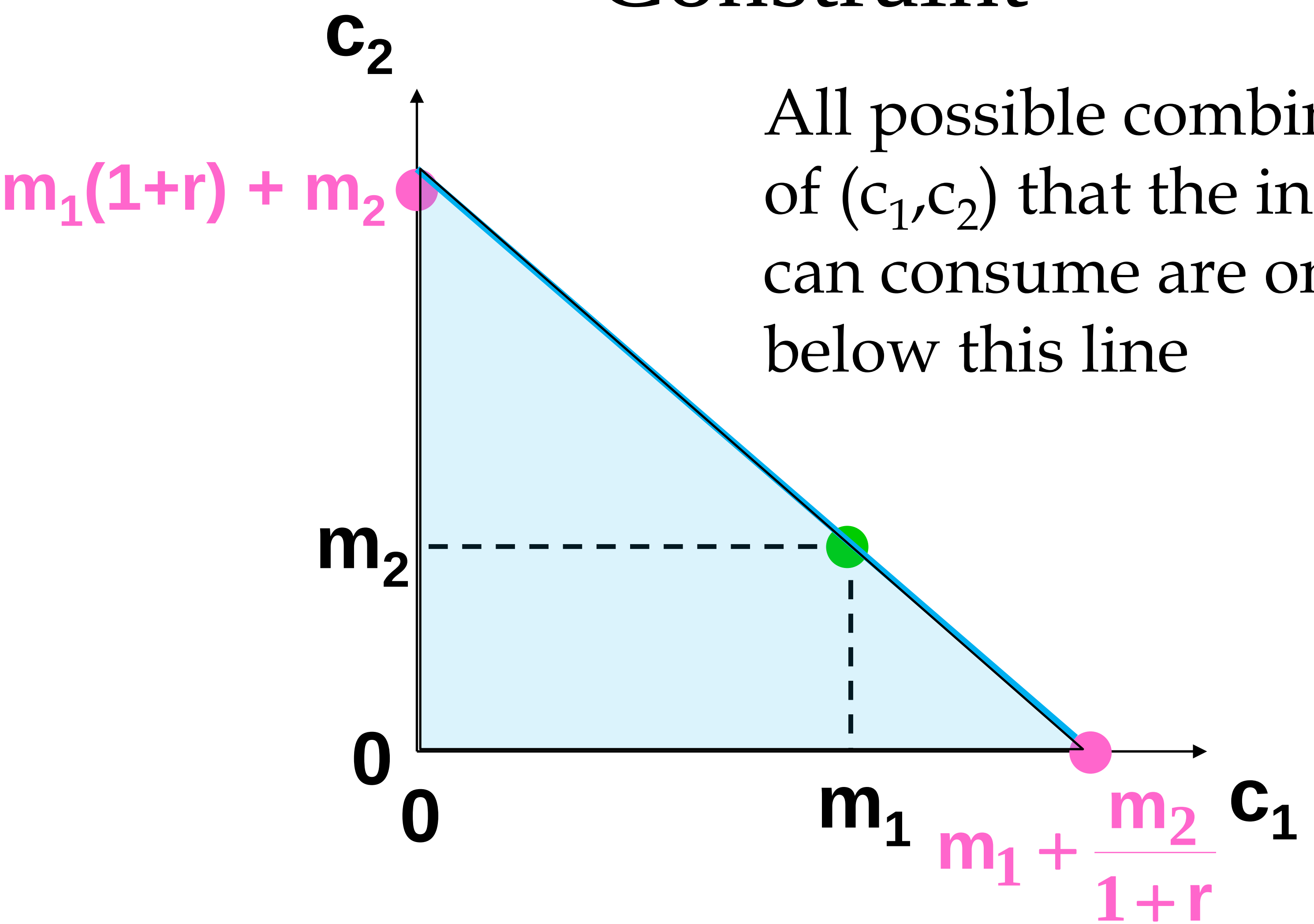
The Intertemporal Budget Constraint

Saving everything for period 2

Borrowing everything from period 2

- These are the most extremes choices an individual can make.
- These points and everything in between (some saving or some borrowing) constitute the budget constraint

The Intertemporal Budget Constraint



All possible combinations of (c_1,c_2) that the individual can consume are on and below this line

The Intertemporal Budget Constraint

- Suppose that c_1 units are consumed in period 1. This costs \$$c_1$ and leaves m_1-c_1 saved. Period 2 consumption will then be

$$c_2 = \underbrace{m_2}_{\text{Period 2 endowment}} + \underbrace{(1 + r)}_{\text{Interest rate gains from Period 1 savings}} \underbrace{(m_1 - c_1)}_{\text{Savings/leftovers from Period 1}}$$

The Intertemporal Budget Constraint

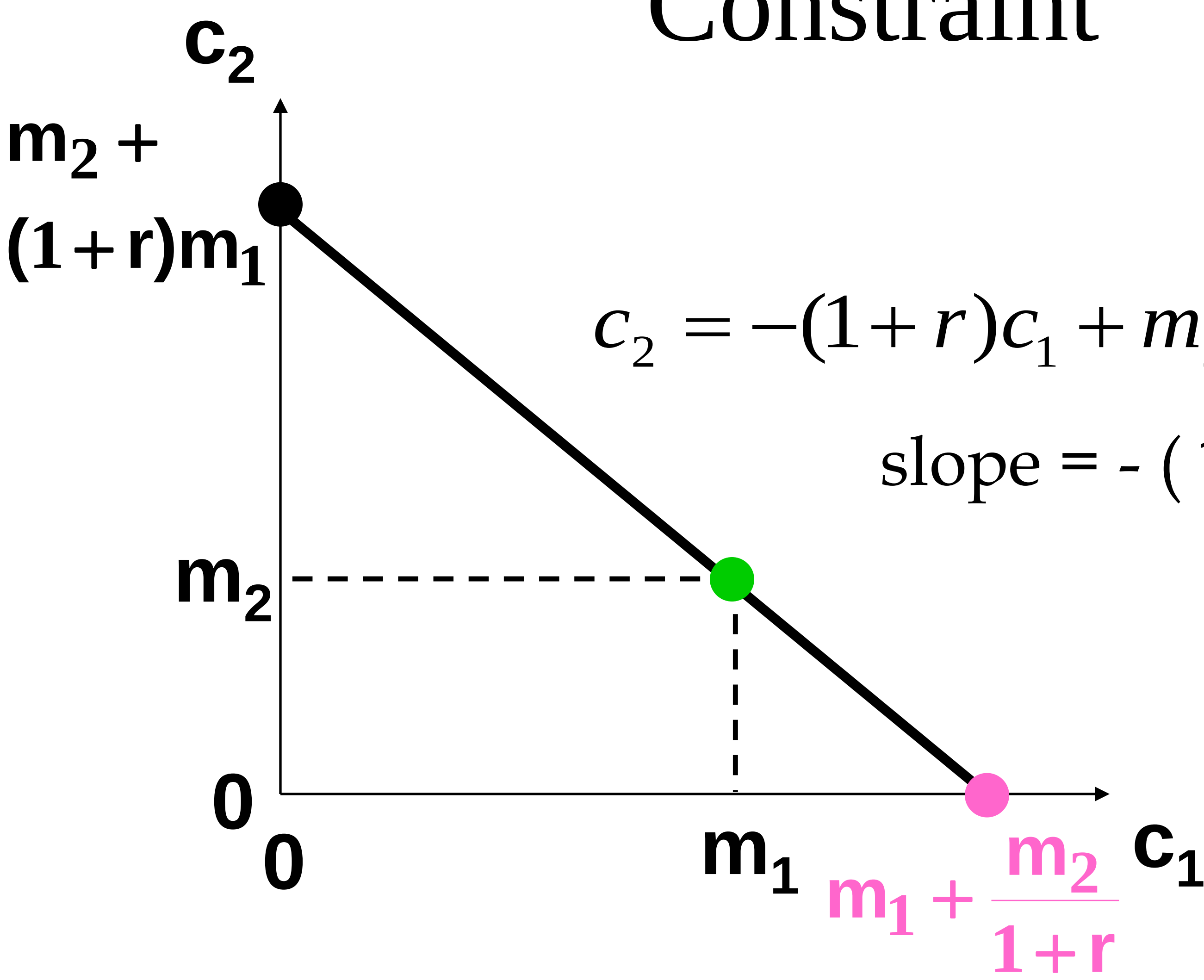
$$c_2 = m_2 + (1+r)(m_1 - c_1)$$

can be rearranged as

$$c_2 = \underbrace{-(1+r)}_{\text{slope}}c_1 + \underbrace{m_2 + (1+r)m_1}_{\text{intercept}}$$

of a line with c_2 on the vertical axis and c_1 on the horizontal axis

The Intertemporal Budget Constraint



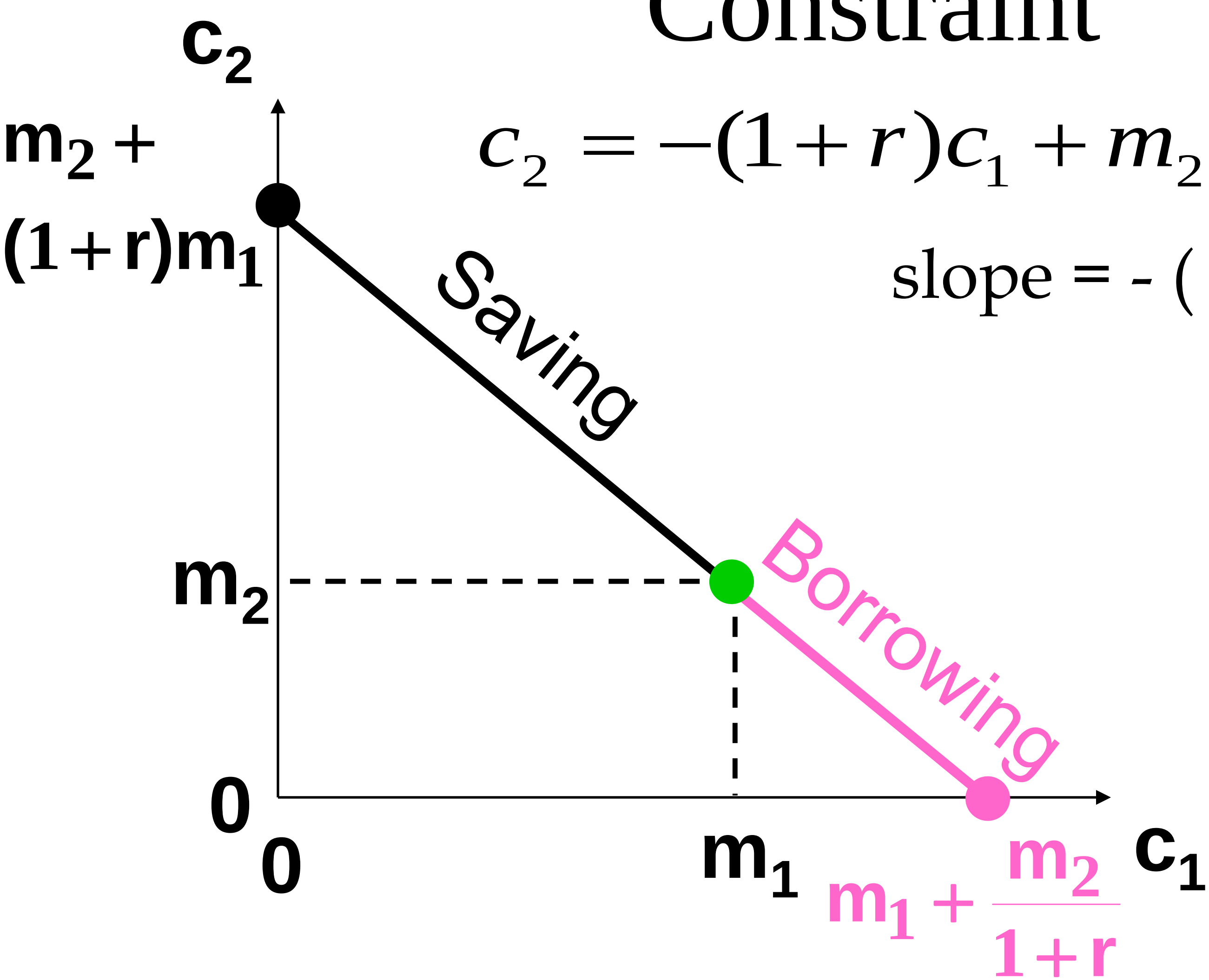
$$c_2 = -(1+r)c_1 + m_2 + (1+r)m_1.$$

slope = - (1+r)

The Intertemporal Budget Constraint

$$c_2 = -(1+r)c_1 + m_2 + (1+r)m_1.$$

slope = - (1+r)



The Intertemporal Budget Constraint

$$(1+r)c_1 + c_2 = (1+r)m_1 + m_2$$

is the “future-valued” form of the budget constraint since all terms are in period 2 values. This is equivalent to

$$c_1 + \frac{c_2}{1+r} = m_1 + \frac{m_2}{1+r}$$

which is the “present-valued” form of the constraint since all terms are in period 1 values.

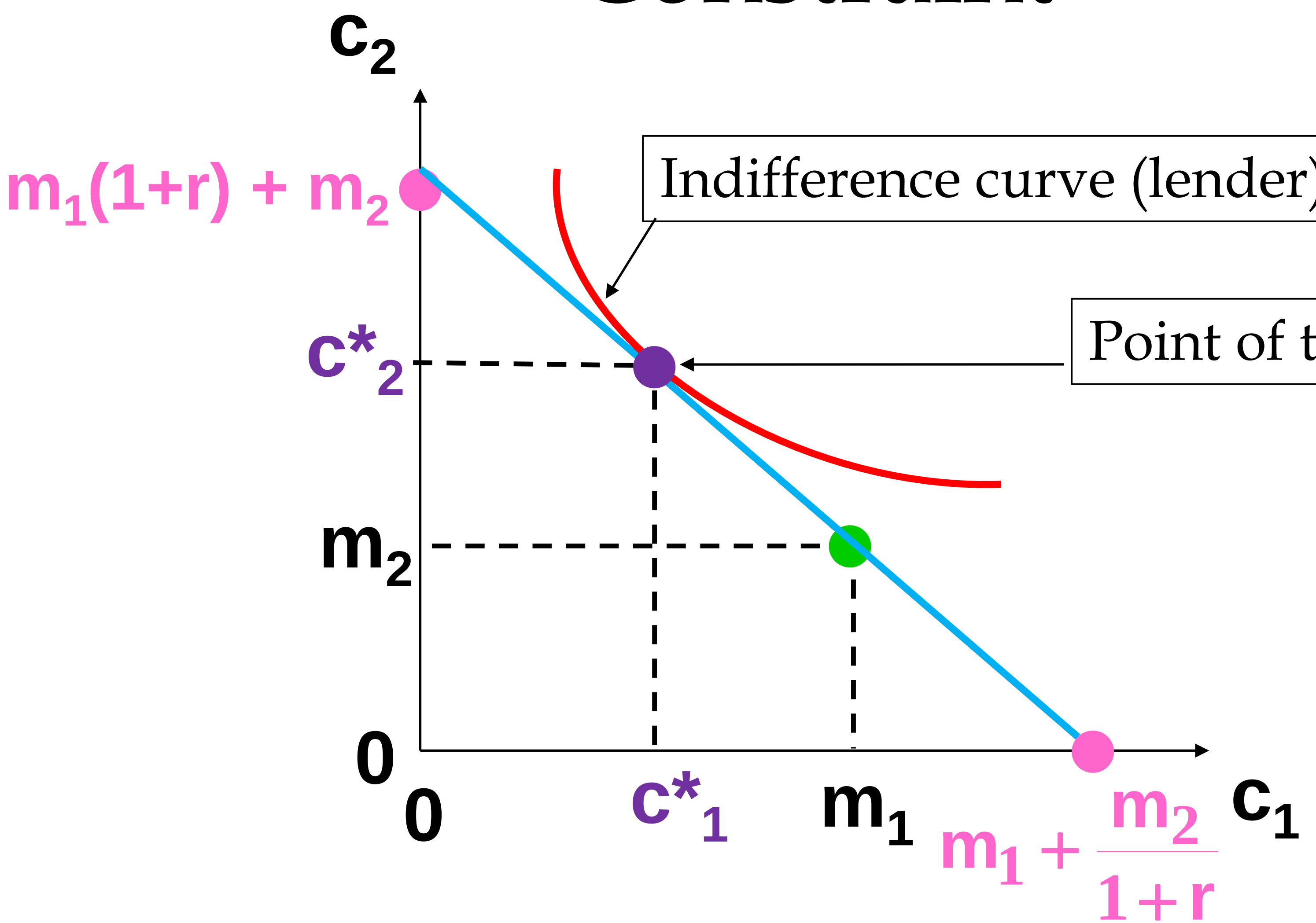
The Intertemporal Budget Constraint

- How do individuals decide how much to consume in each period?
- They want to choose the bundle that maximizes utility.
- If we trace out indifference curves (bundles which yield individuals equal utility), then we want to find the indifference curve furthest from the origin

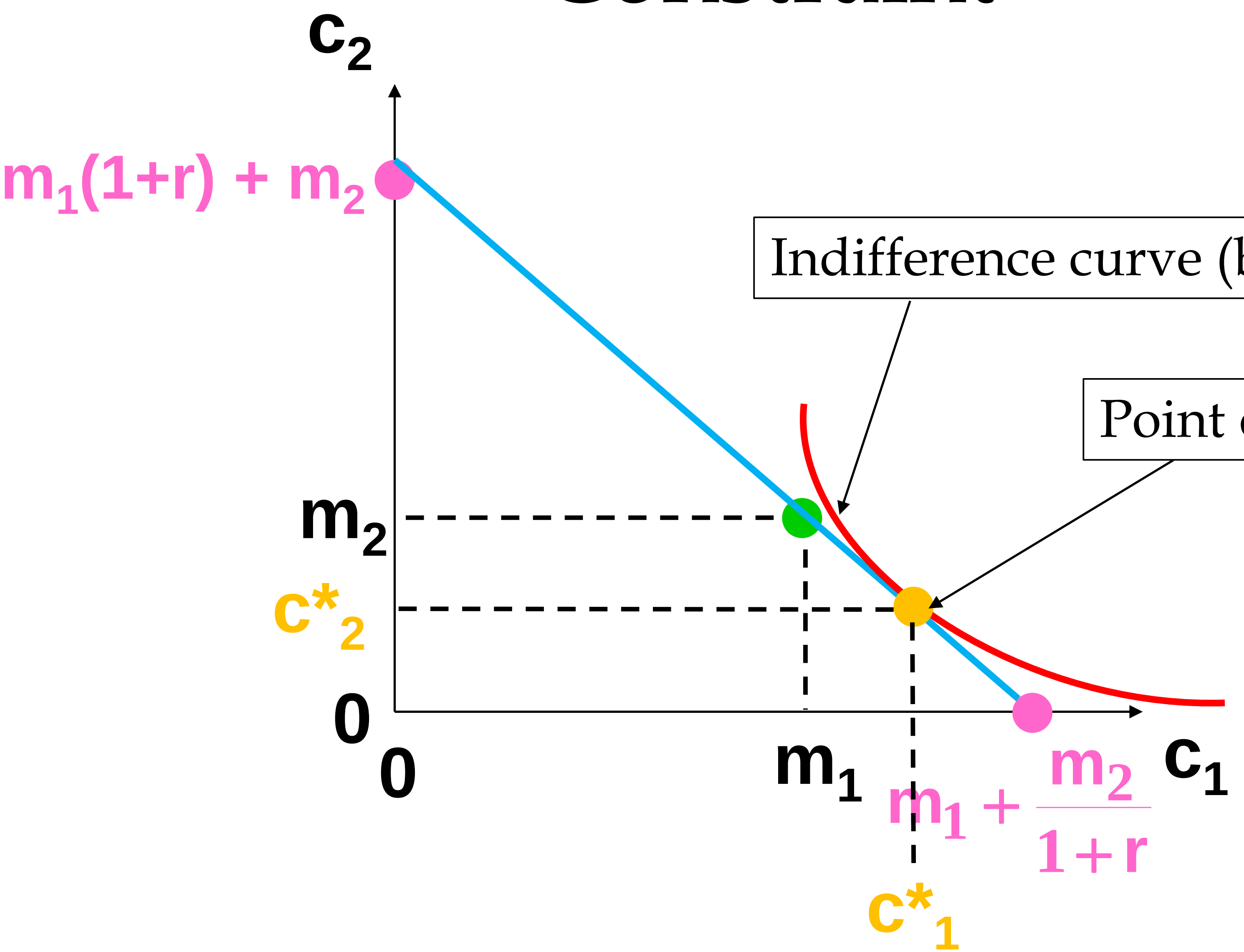
The Intertemporal Budget Constraint

- To find the indifference curve furthest from the origin that still satisfies the budget constraint, we look for the indifference curve tangent to the budget constraint.

The Intertemporal Budget Constraint



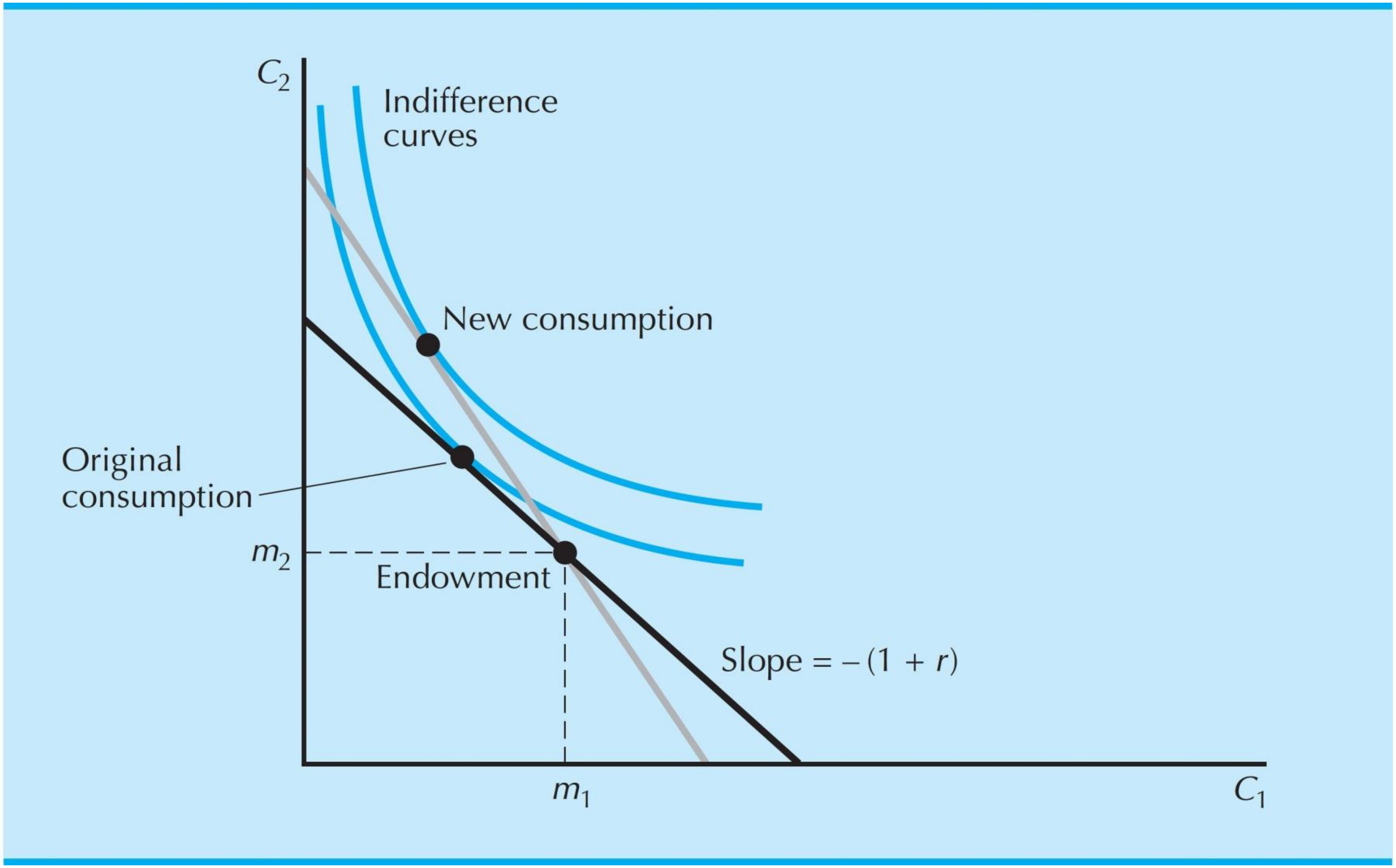
The Intertemporal Budget Constraint



The Intertemporal Budget Constraint

- What if there was an increase in the interest rate?
- Borrowing is now costlier and saving is more rewarding

Figure 10.4



- A saver is now better off and will remain a saver

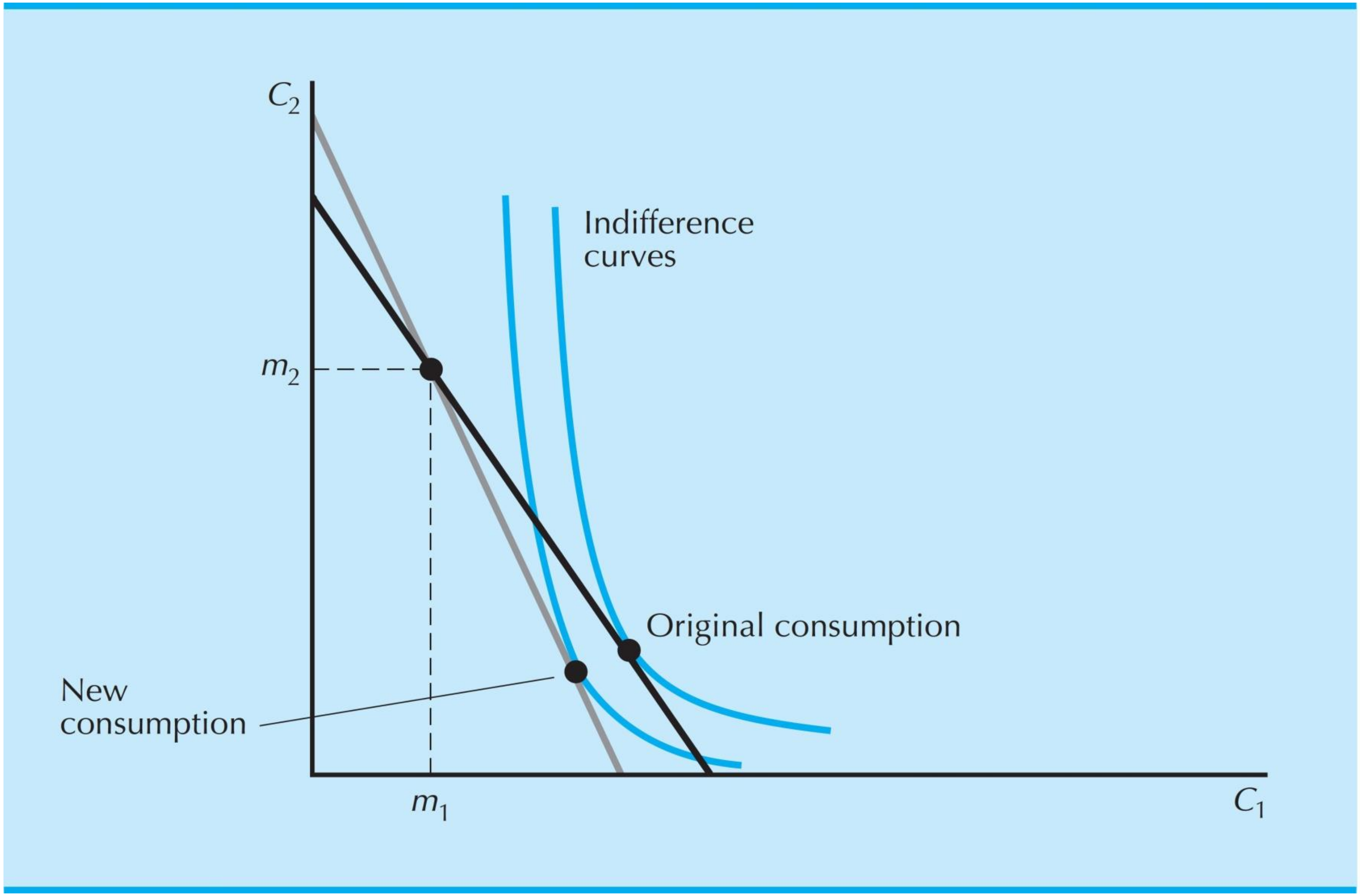


Figure 10.5

- A borrower is now worse off and could decide to become a saver

The Intertemporal Budget Constraint

- Now let’s add prices p_1 and p_2 for consumption in periods 1 and 2.
- How does this affect the budget constraint?

Intertemporal Choice

- Given her endowment (m_1,m_2) and prices p_1, p_2 what intertemporal consumption bundle (c_1^*,c_2^*) will be chosen by the consumer?
- Maximum possible expenditure in period 2 is $m_2 + (1+r)m_1$
so maximum possible consumption in period 2 is $c_2 = \frac{m_2+(1+r)m_1}{p_2}$

Intertemporal Choice

- Similarly, maximum possible expenditure in period 1 is

$$m_1 + \frac{m_2}{1+r}$$

so maximum possible consumption in period 1 is

$$c_1 = \frac{m_1 + \frac{m_2}{1+r}}{p_1}$$

Intertemporal Choice

- Finally, if c_1 units are consumed in period 1 then the consumer spends p_1c_1 in period 1, leaving m_1 - p_1c_1 saved for period 1. Available income in period 2 will then be

$$m_2 + (1 + r)(m_1 - p_1 c_1)$$

so

$$p_2 c_2 = m_2 + (1 + r)(m_1 - p_1 c_1).$$

Intertemporal Choice

$$p_2 c_2 = m_2 + (1 + r)(m_1 - p_1 c_1)$$

can be rearranged to

$$(1 + r)p_1 c_1 + p_2 c_2 = (1 + r)m_1 + m_2$$

This is the "future-valued" form of the budget constraint since all terms are expressed in period 2 values.

Intertemporal Choice

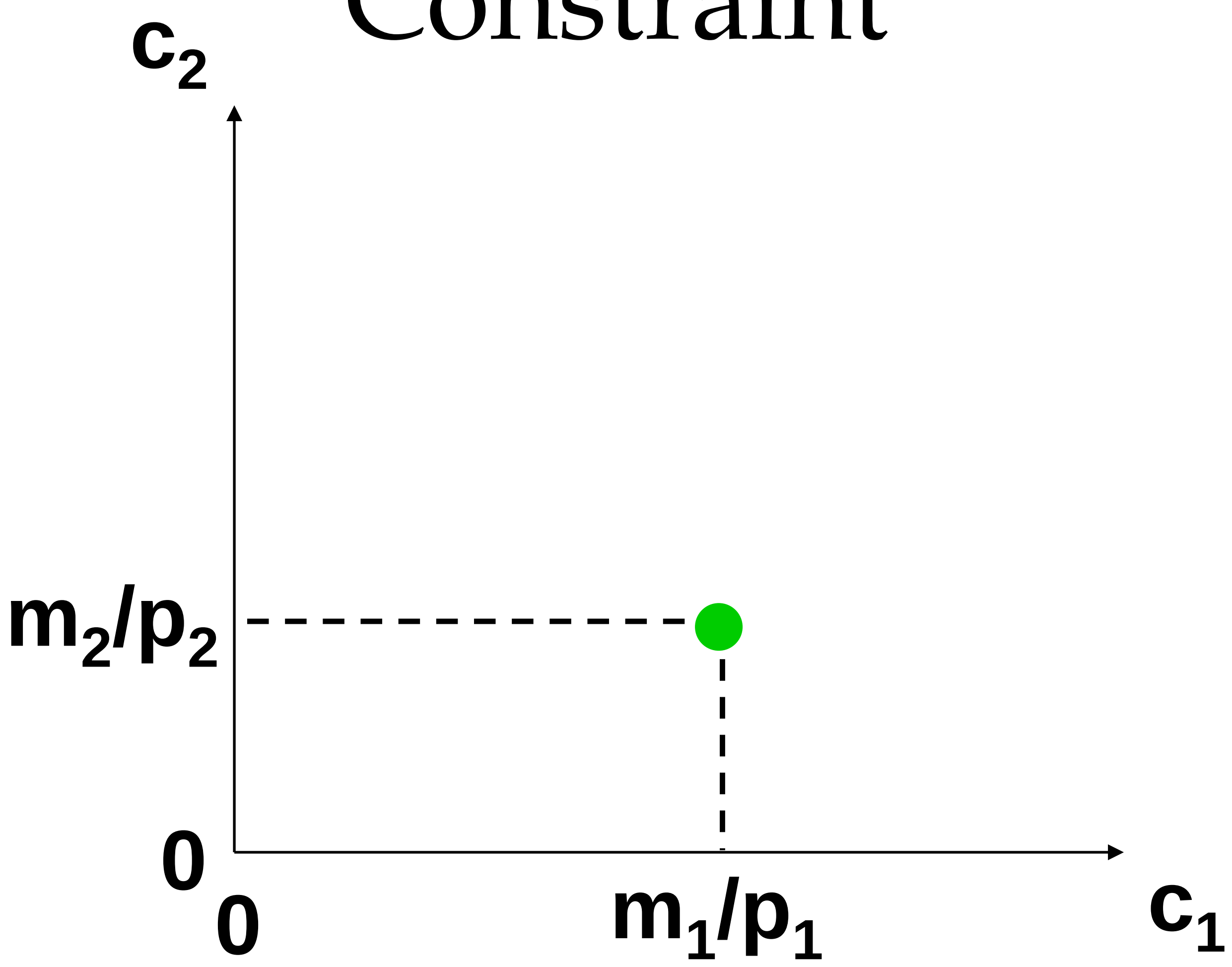
Equivalent to it is the "present-valued" form:

$$p_1 c_1 + \frac{p_2}{1+r} c_2 = m_1 + \frac{m_2}{1+r}$$

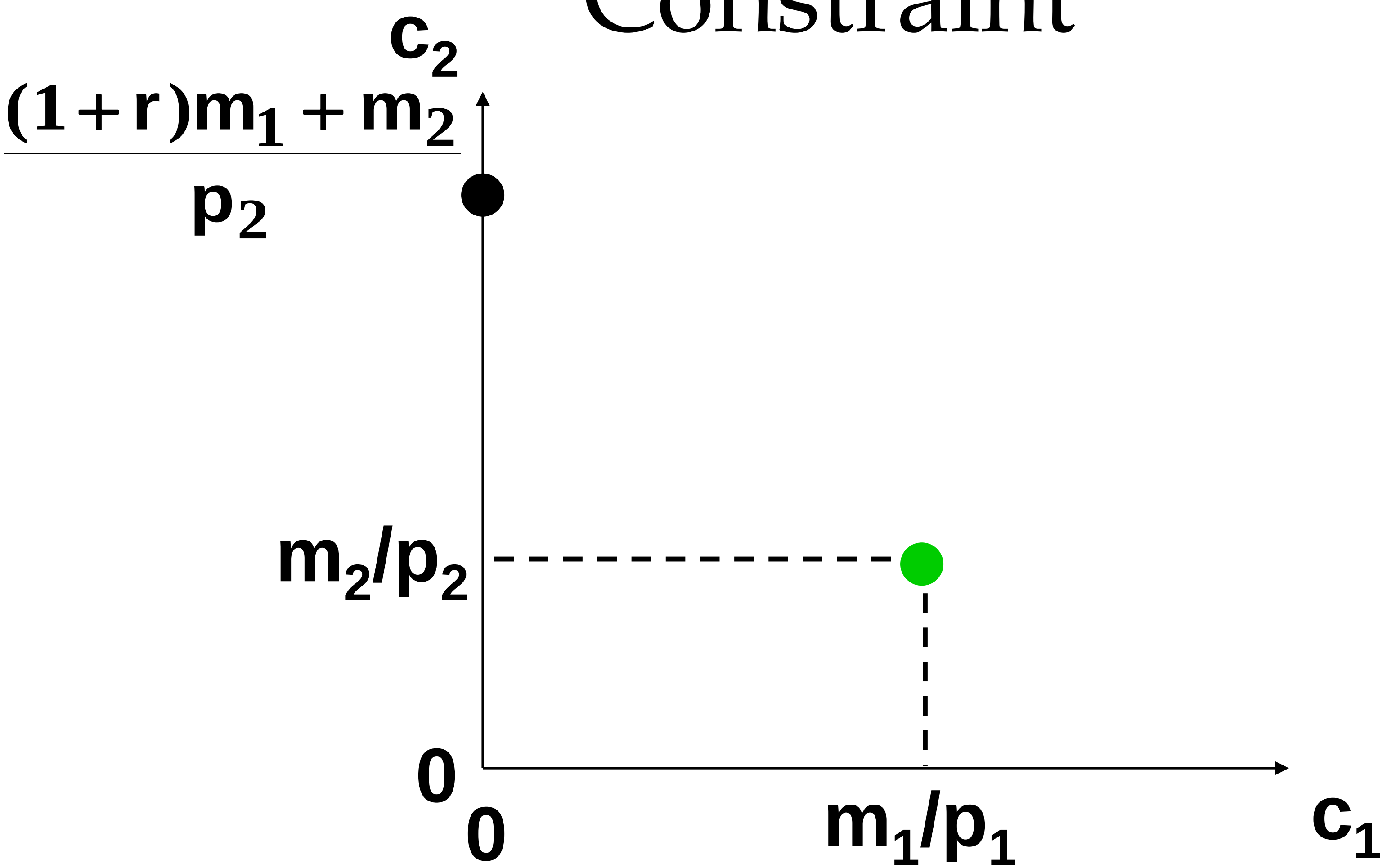
Solving for c_2, we have:

$$\mathrm{c}_2 = \underbrace{-(1+\mathrm{r})\frac{p_1}{p_2}}_{\text{slope}}\mathrm{c}_1 + \underbrace{\frac{(1+\mathrm{r})\mathrm{m}_1 + \mathrm{m}_2}{p_2}}_{\text{intercept}}$$

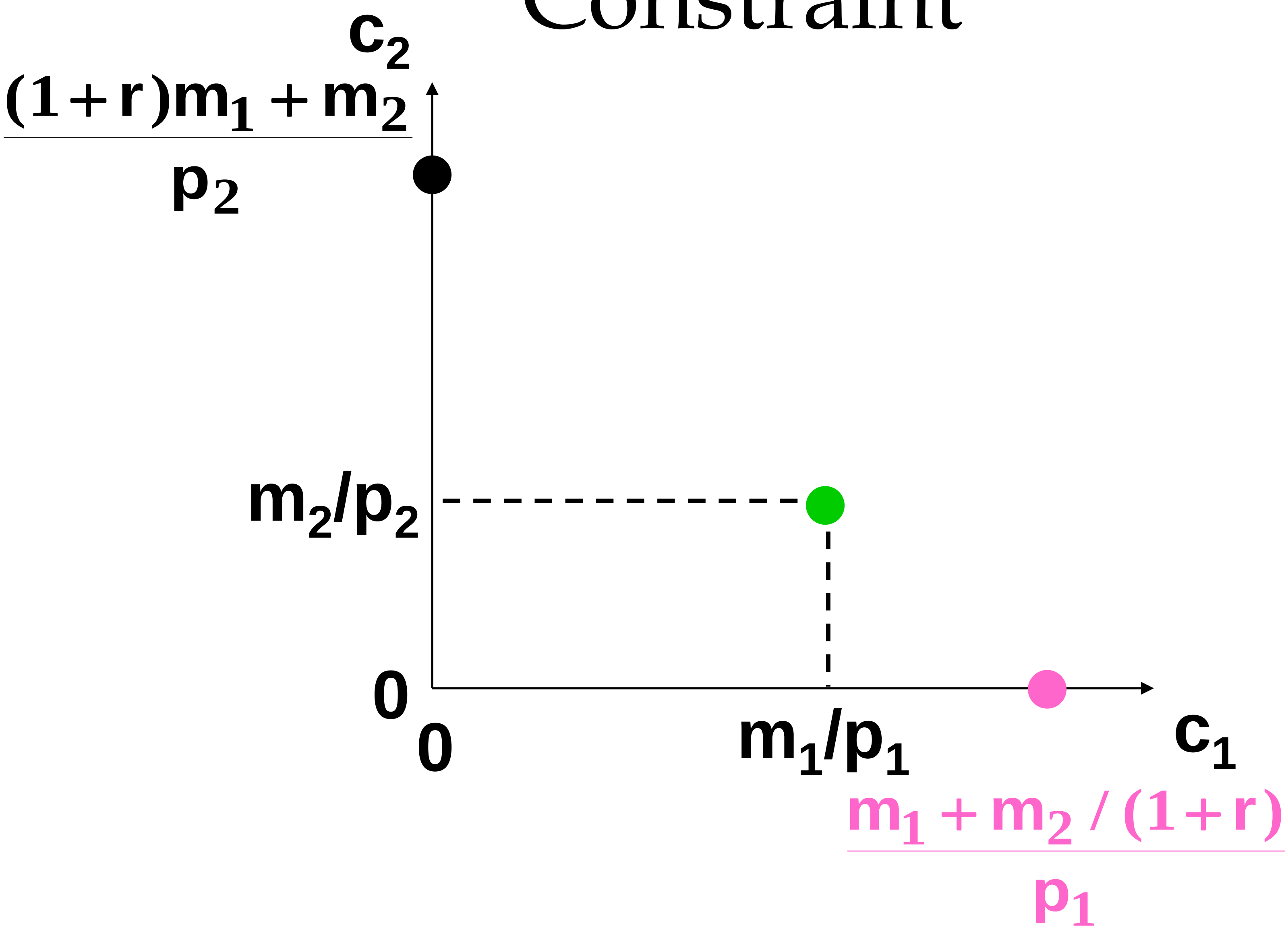
The Intertemporal Budget Constraint



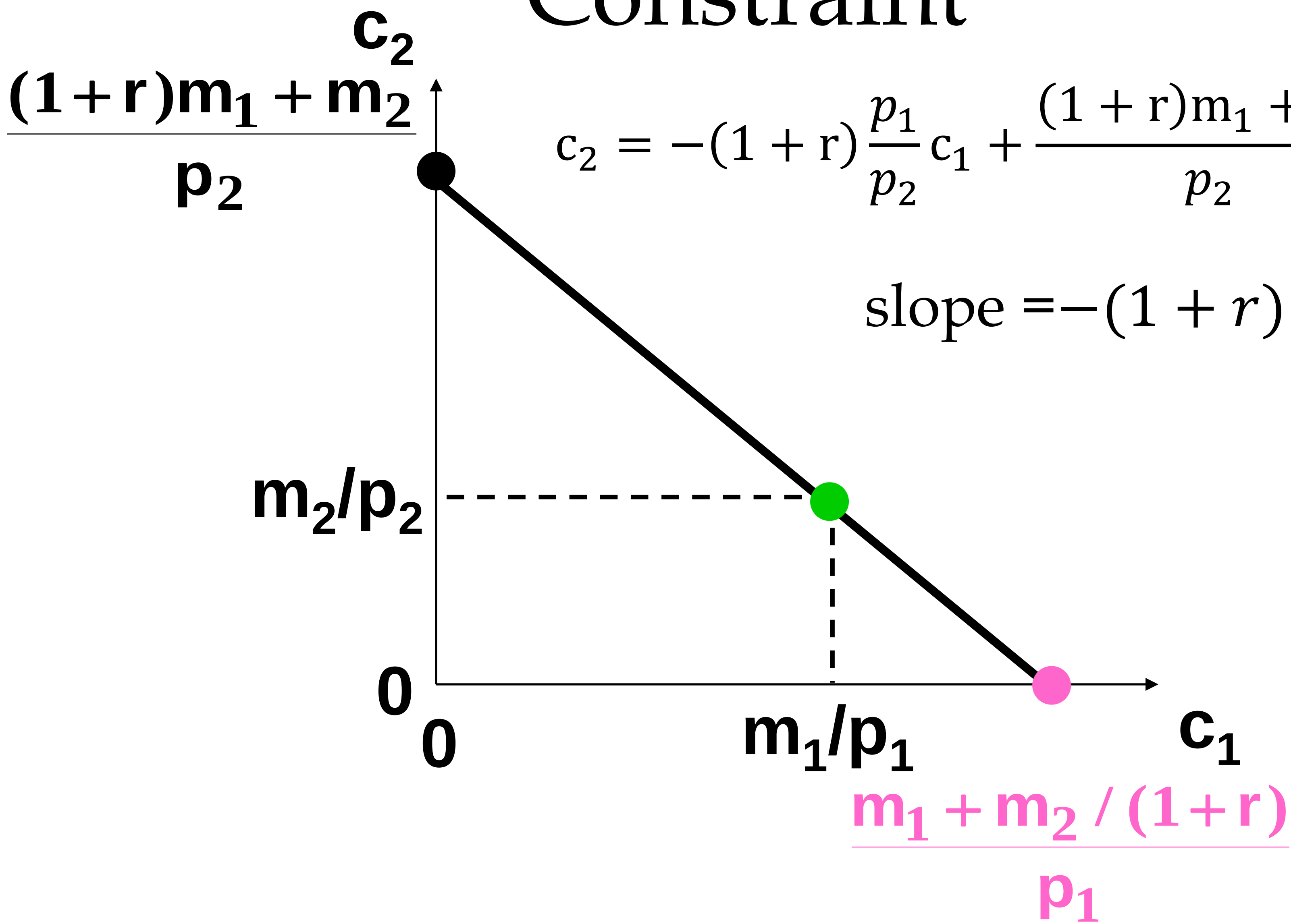
The Intertemporal Budget Constraint



The Intertemporal Budget Constraint



The Intertemporal Budget Constraint



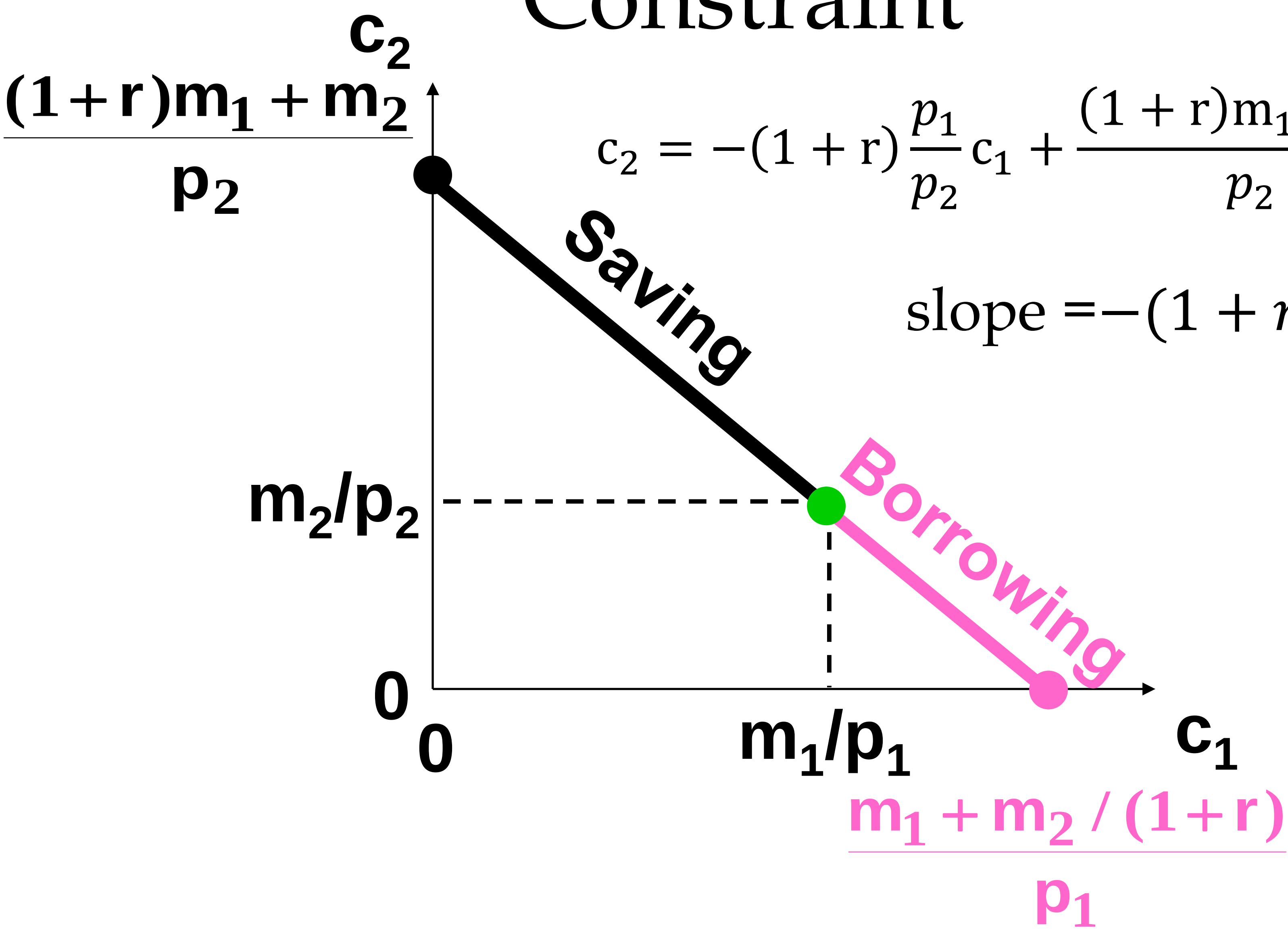
$$c_2 = -(1+r)\frac{p_1}{p_2}c_1 + \frac{(1+r)m_1+m_2}{p_2}$$

$$\text{slope} = -(1+r)\frac{p_1}{p_2}$$

The Intertemporal Budget Constraint

$$c_2 = -(1+r)\frac{p_1}{p_2}c_1 + \frac{(1+r)m_1 + m_2}{p_2}$$

$$\text{slope} = -(1+r)\frac{p_1}{p_2}$$



Price Inflation

- Define the inflation rate by π where
$$p_1(1+\pi) = p_2$$
- For example,
$\pi = 0.2$ means 20% inflation, and
$\pi = 1.0$ means 100% inflation.

Price Inflation

- We lose nothing by setting $p_1=1$ so that $p_2 = 1+ \pi$.
- Then we can rewrite the budget constraint

$$p_1 c_1 + \frac{p_2}{1+r} c_2 = m_1 + \frac{m_2}{1+r}$$

as
$$c_1 + \frac{1+\pi}{1+r} c_2 = m_1 + \frac{m_2}{1+r}$$

Price Inflation

$$c_1 + \frac{1+\pi}{1+r}c_2 = m_1 + \frac{m_2}{1+r}$$

can be rearranged to

$$c_2 = \underbrace{-\frac{1+r}{1+\pi}}_{\text{slope}}c_1 + \underbrace{\frac{1+r}{1+\pi}\left(m_1 + \frac{m_2}{1+r}\right)}_{\text{intercept}}$$

Price Inflation

- When there was no price inflation (p_1=p_2=1) the slope of the budget constraint was -(1+r).
- Now, with price inflation, the slope of the budget constraint is $-\frac{1+r}{1+\pi}$. This can be written as

$$-(1+\rho) = -\frac{1+r}{1+\pi}$$

ρ is known as the real interest rate.

Real Interest Rate

$$-(1+\rho) = -\frac{1+r}{1+\pi}$$

Gives

$$\rho = \frac{r-\pi}{1+\pi}$$

For low inflation rates ($\pi \approx 0$), $\rho \approx \mathrm{r} - \pi$. For higher inflation rates this approximation becomes poor.

Real Interest Rate

r	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**
π	**0.0**	**0.05**	**0.10**	**0.20**	**1.00**
r - π	**0.30**	**0.25**	**0.20**	**0.10**	**-0.70**
ρ	**0.30**	**0.24**	**0.18**	**0.08**	**-0.35**

Comparative Statics

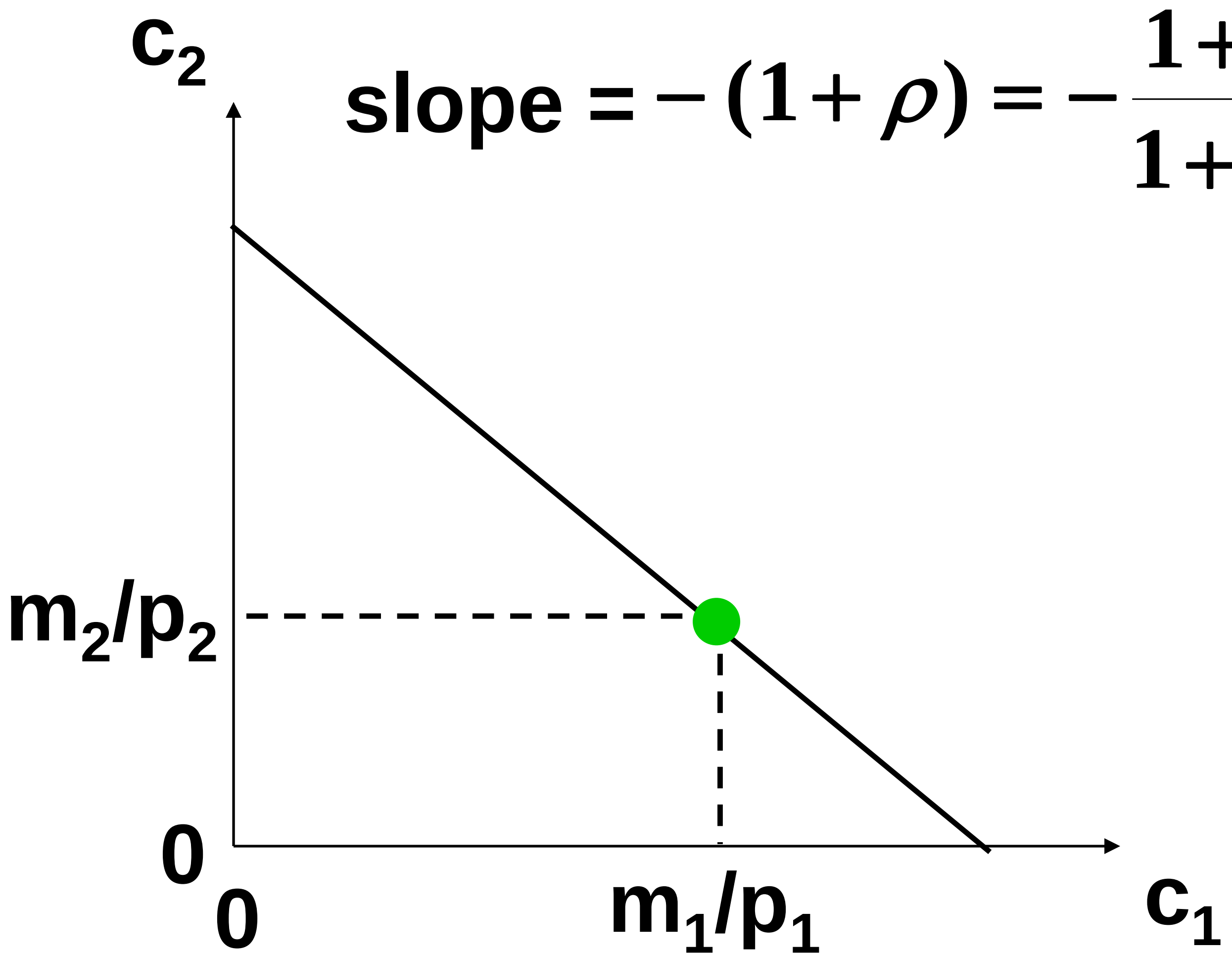
- The slope of the budget constraint is

$$-(1+\rho) = -\frac{1+r}{1+\pi}$$

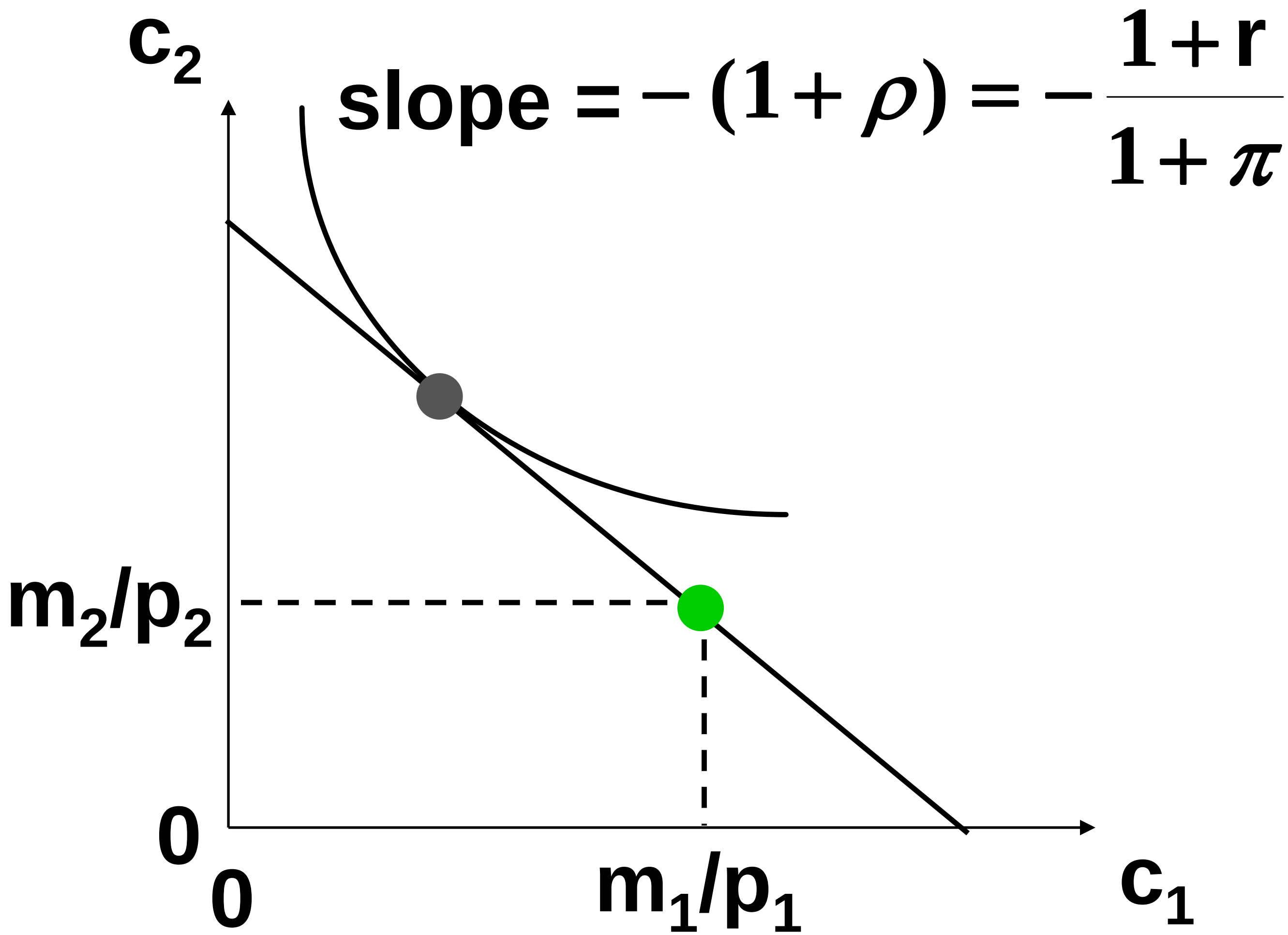
- The constraint becomes flatter if the interest rate, r, falls or the inflation rate, π, rises (both decrease the real rate of interest).

Comparative Statics

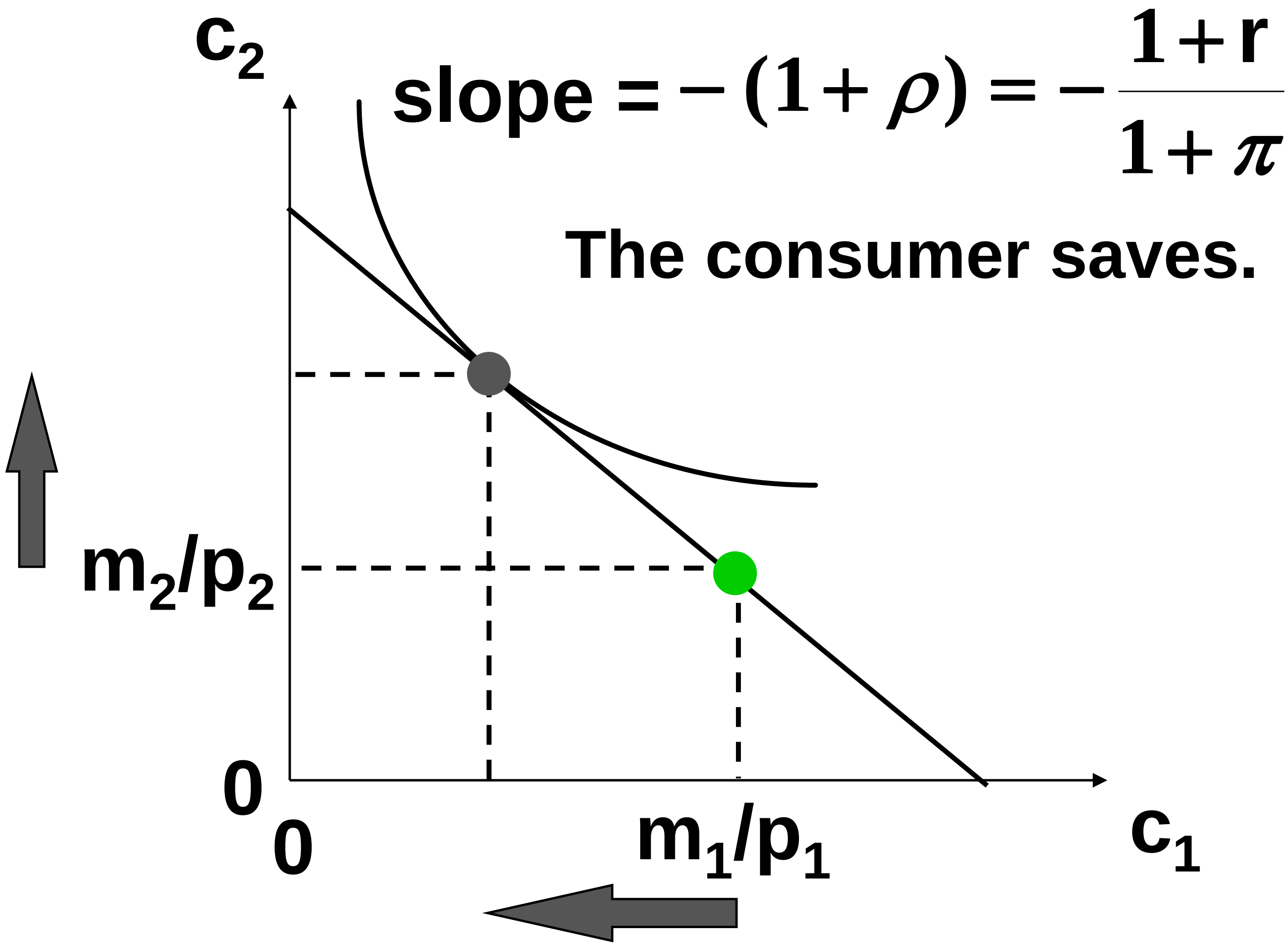
$$\text{slope} = -(1+\rho) = -\frac{1+r}{1+\pi}$$



Comparative Statics



Comparative Statics



Comparative Statics

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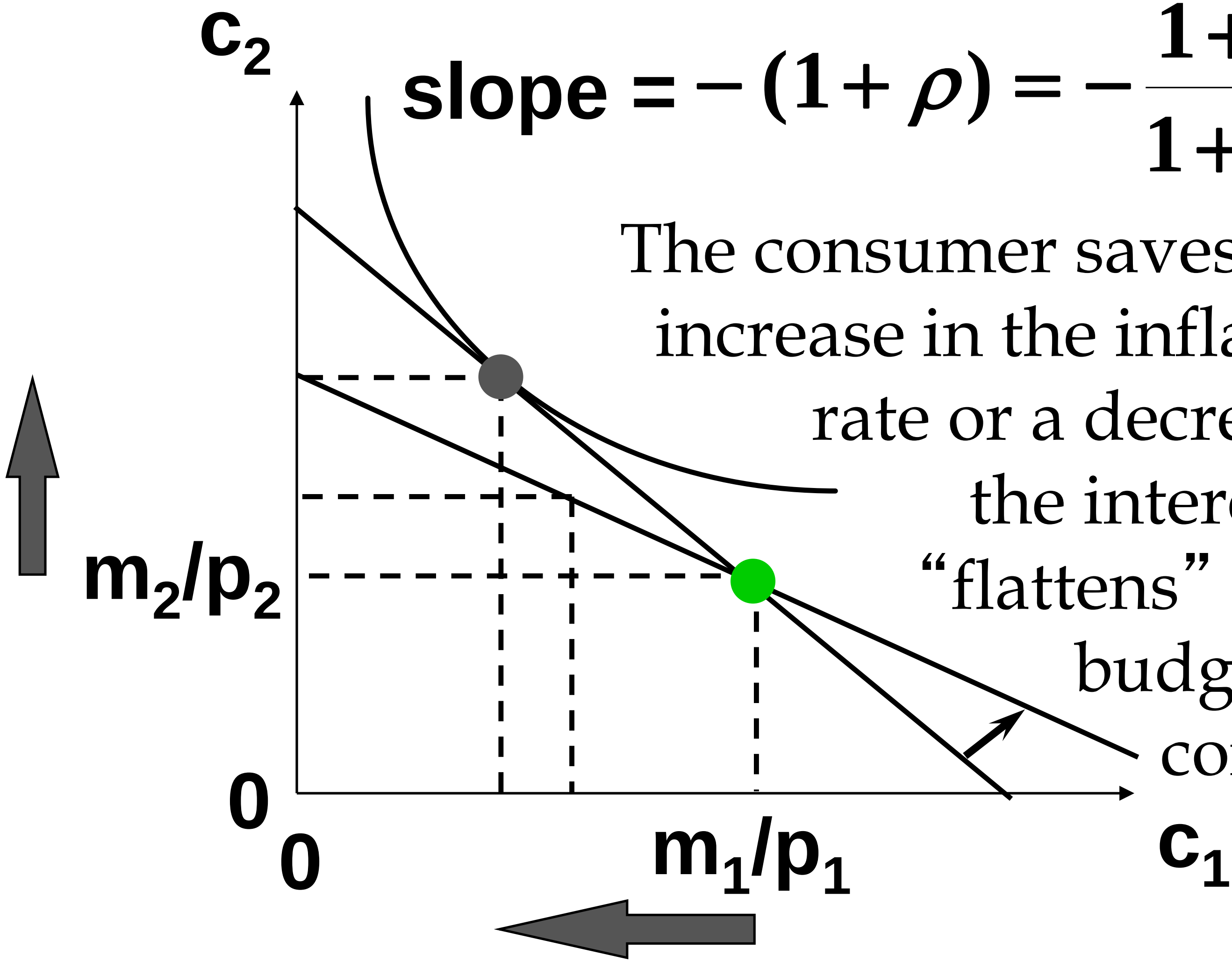
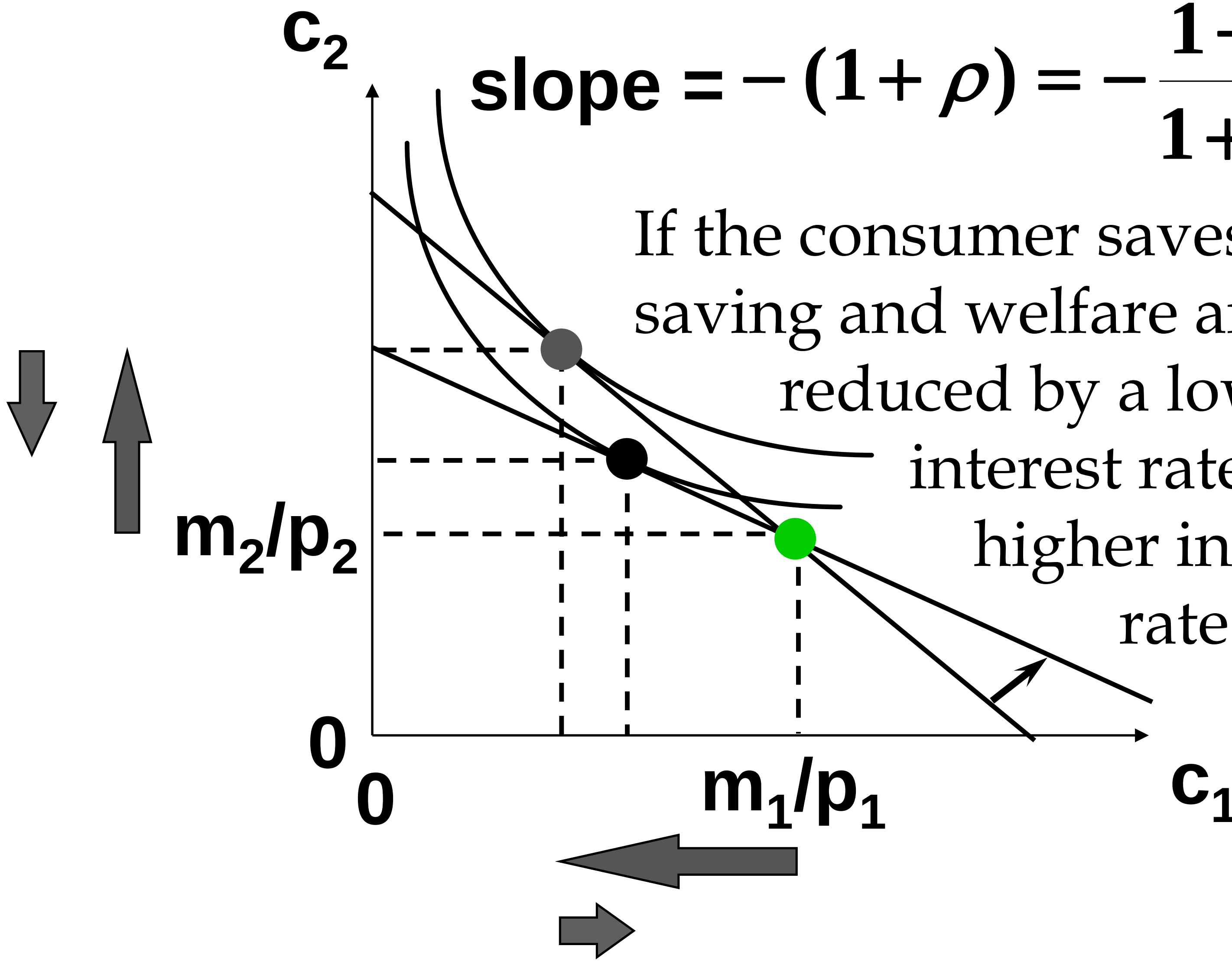


The consumer saves. An increase in the inflation rate or a decrease in the interest rate "flattens" the budget constraint.

Comparative Statics

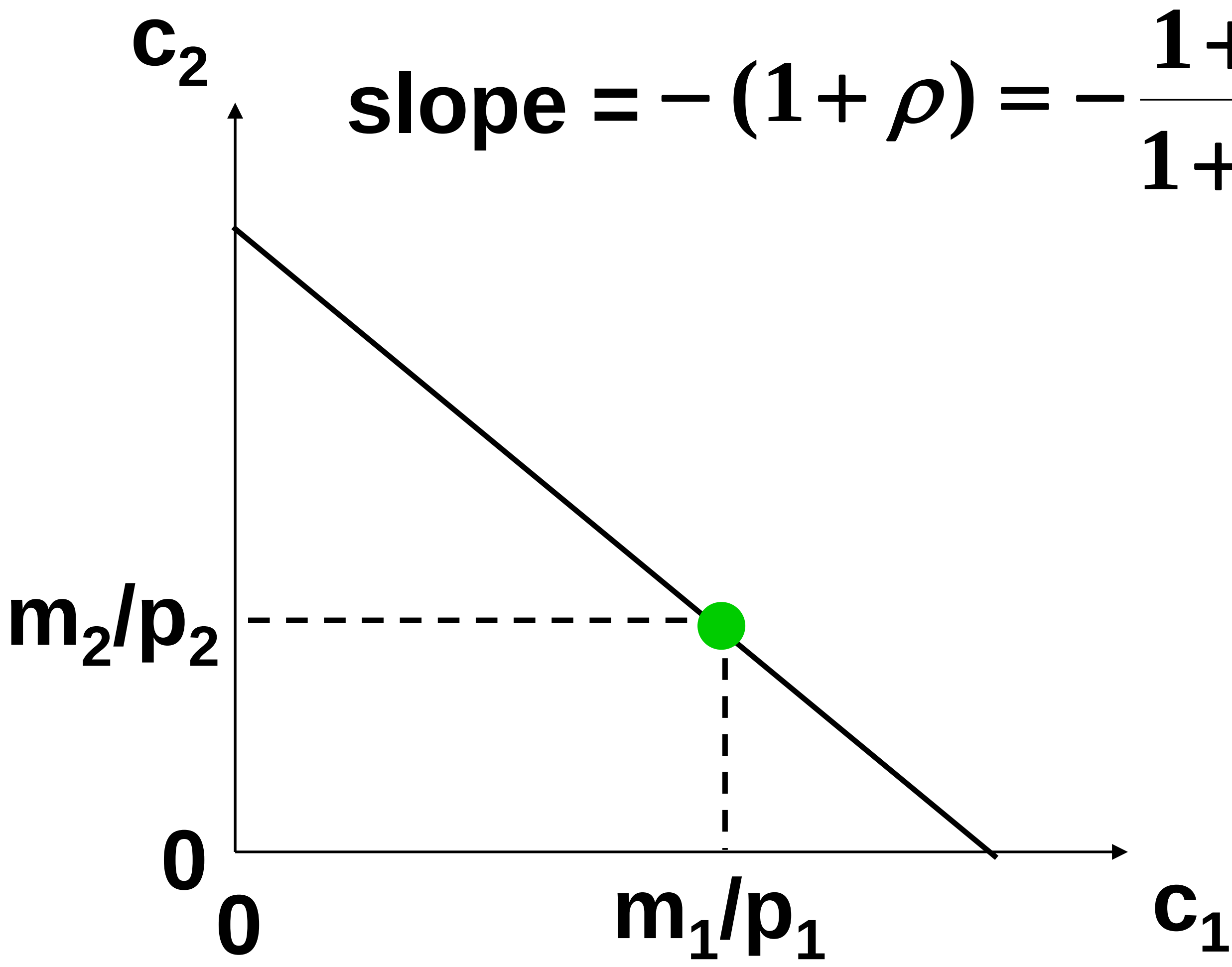
$$\text{slope} = -(1+\rho) = -\frac{1+r}{1+\pi}$$



If the consumer saves then saving and welfare are reduced by a lower interest rate or a higher inflation rate.

Comparative Statics

$$\text{slope} = -(1+\rho) = -\frac{1+r}{1+\pi}$$



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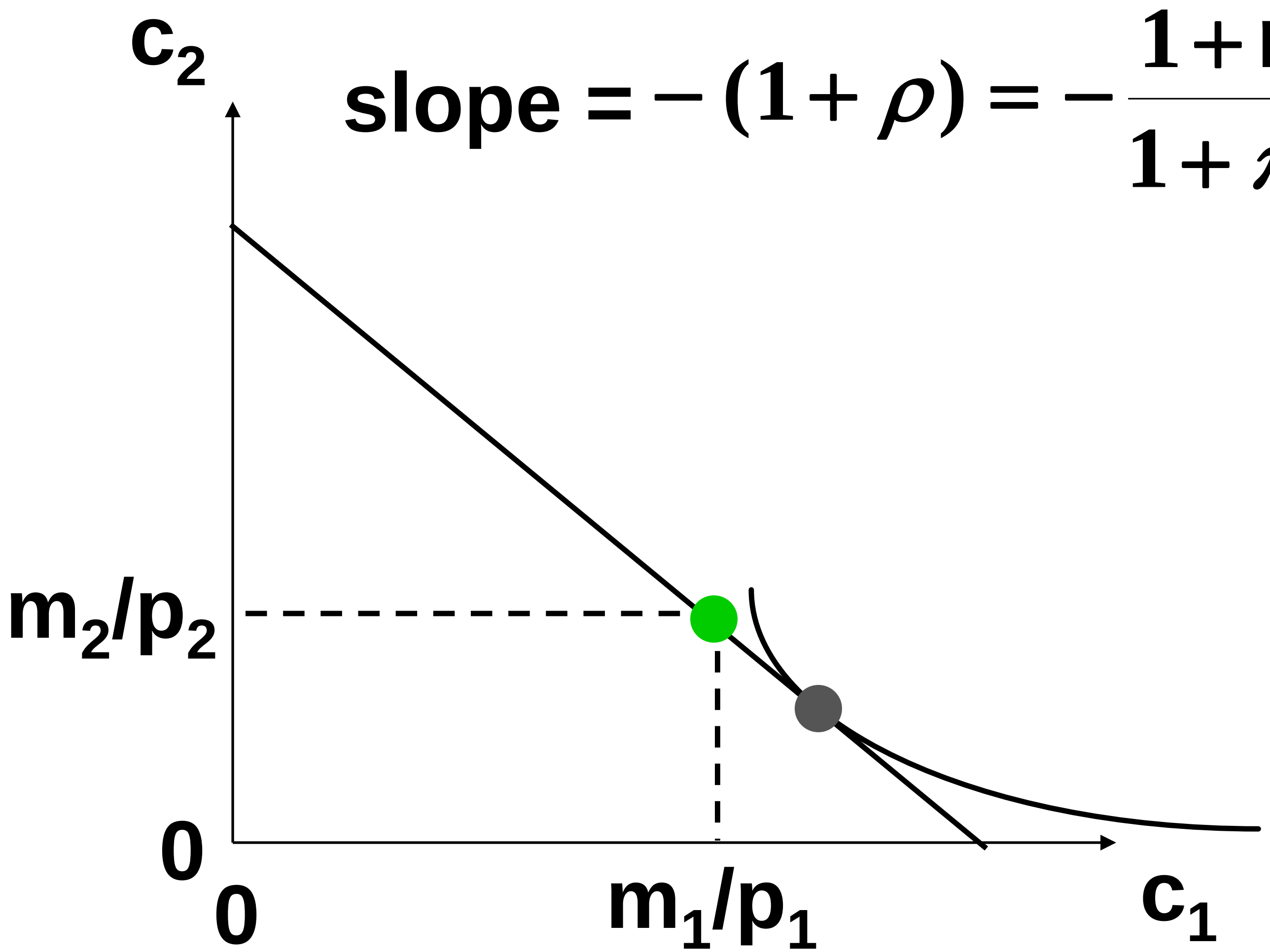
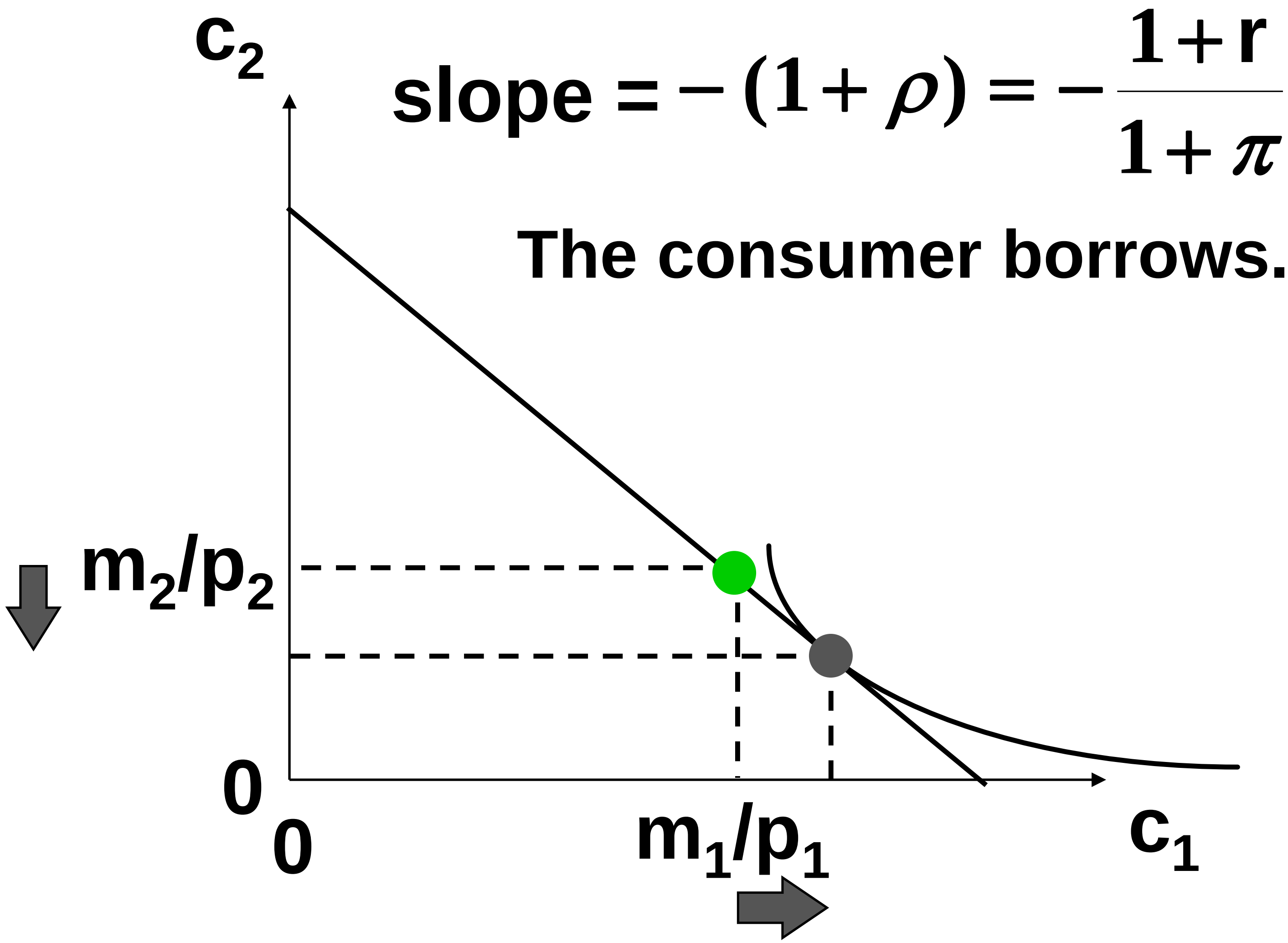


Comparative Statics

$$\textbf{slope} = -(1+\rho) = -\frac{1+r}{1+\pi}$$

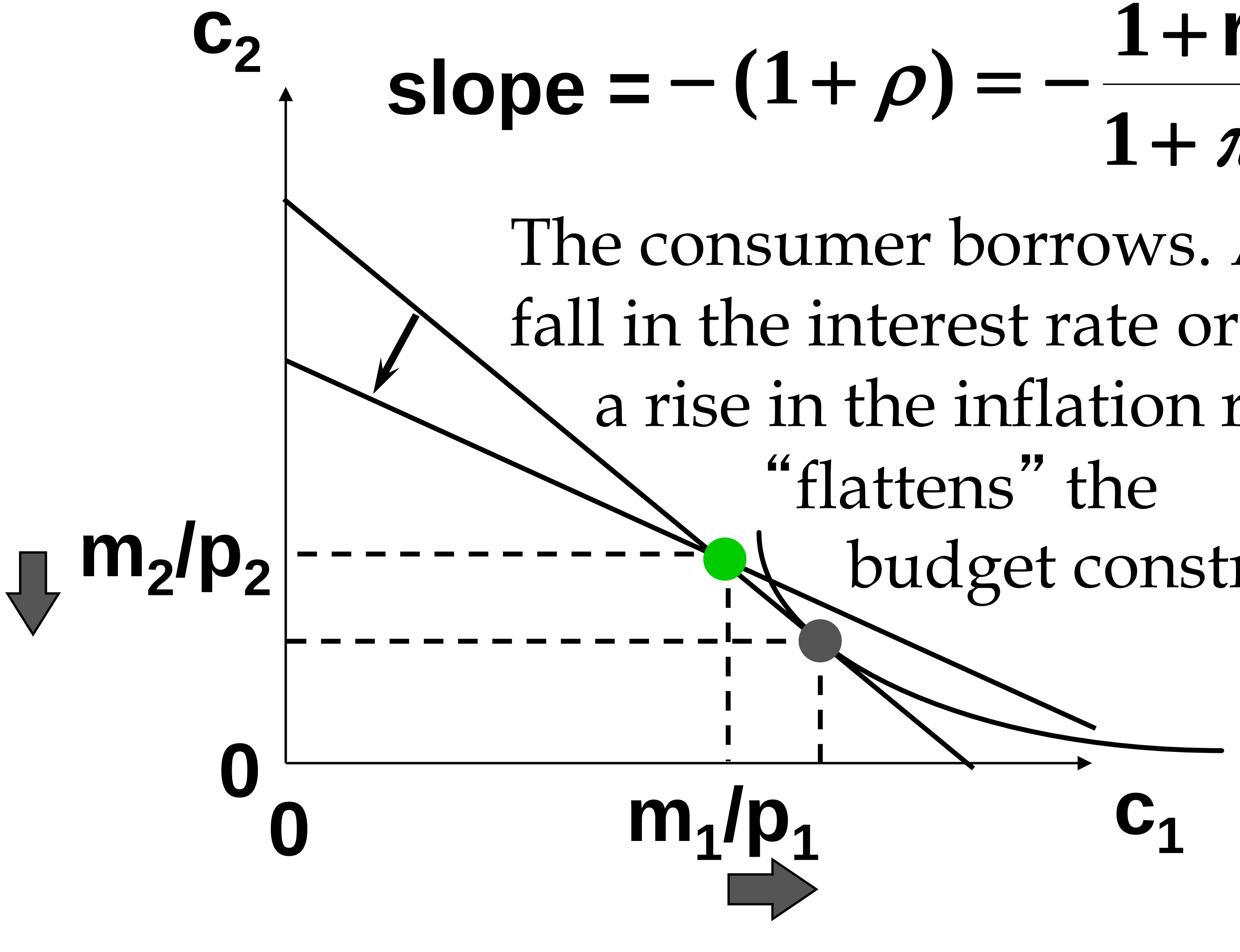
The consumer borrows.



Comparative Statics

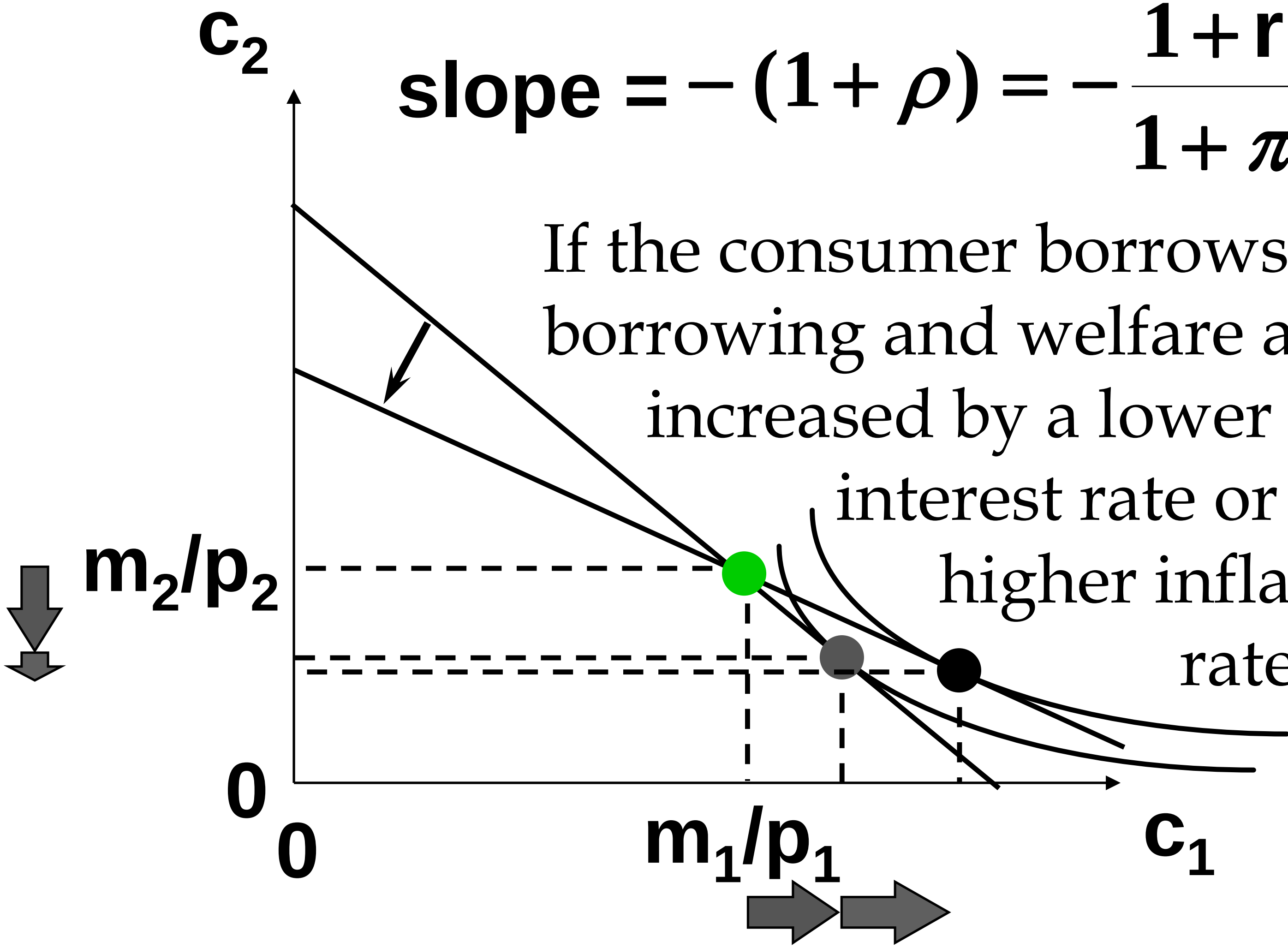
$$\text{slope} = -(1+\rho) = -\frac{1+r}{1+\pi}$$

The consumer borrows. A fall in the interest rate or a rise in the inflation rate "flattens" the budget constraint.



Comparative Statics

$$\text{slope} = -(1+\rho) = -\frac{1+r}{1+\pi}$$



If the consumer borrows then borrowing and welfare are increased by a lower interest rate or a higher inflation rate.

Valuing Securities

- A financial security is a financial instrument that promises to deliver an income stream.
- E.g.; a security that pays
  - $\$m_1$ at the end of year 1,
  - $\$m_2$ at the end of year 2, and
  - $\$m_3$ at the end of year 3.
- What is the most that should be paid now for this security?

Valuing Securities

- The security is equivalent to the sum of three securities;
  - the first pays only $\$m_1$ at the end of year 1,
  - the second pays only $\$m_2$ at the end of year 2, and
  - the third pays only $\$m_3$ at the end of year 3.

Valuing Securities

The PV of $\$m_1$ paid 1 year from now is

$$\frac{m_1}{1+r}$$

The PV of $\$m_2$ paid 2 years from now is

$$\frac{m_2}{(1+r)^2}$$

The PV of $\$m_3$ paid 3 years from now is

$$\frac{m_3}{(1+r)^3}$$

Valuing Securities

- The PV of the security is therefore:
$$\frac{m_1}{1+r} + \frac{m_2}{(1+r)^2} + \frac{m_3}{(1+r)^3}$$

Valuing Bonds

- A bond is a special type of security that pays a fixed amount \$x for T years (its maturity date) and then pays its face value \$F.
- What is the most that should now be paid for such a bond?

Valuing Bonds

End of Year	1	2	3	…	T-1	T
Income paid	x	x	x	x	x	F
Present value	$\frac{x}{1+r}$	$\frac{x}{(1+r)^2}$	$\frac{x}{(1+r)^3}$	…	$\frac{x}{(1+r)^{T-1}}$	$\frac{F}{(1+r)^T}$

$$PV = \frac{x}{1+r} + \frac{x}{(1+r)^2} + \frac{x}{(1+r)^3} + \dots + \frac{x}{(1+r)^{T-1}} + \frac{\text{X+}\ \ F}{(1+r)^T}$$

Valuing Bonds

- Suppose you win a State lottery. The prize is $1,000,000 but it is paid over 10 years in equal installments of $100,000 each. The interest rate, r, is 0.1. What is the prize actually worth?

Answer: $614,457

Valuing Consols

- A consol is a bond which never terminates, paying \$x per period forever.
- What is a consol's present-value?

Valuing Consols

End of Year	1	2	3	…	t	…
Income Paid	\$x	\$x	\$x	\$x	\$x	\$x
Present -Value	$\frac{\$x}{1+r}$	$\frac{\$x}{(1+r)^2}$	$\frac{\$x}{(1+r)^3}$	…	$\frac{\$x}{(1+r)^t}$	…

$$PV = \frac{x}{1+r} + \frac{x}{(1+r)^2} + \ldots + \frac{x}{(1+r)^t} + \ldots.$$

Valuing Consols

$$PV = \frac{x}{1+r} + \frac{x}{(1+r)^2} + \frac{x}{(1+r)^3} + \ldots$$

$$= \frac{1}{1+r}\left[x + \frac{x}{1+r} + \frac{x}{(1+r)^2} + \ldots\right]$$

$$= \frac{1}{1+r}[x + PV].$$

Solving for PV gives

$$PV = \frac{x}{r}.$$

Valuing Consols

E.g. if r = 0.1 now and forever then the most that should be paid now for a console that provides $1000 per year is

$$\mathbf{PV} = \frac{\mathbf{x}}{\mathbf{r}} = \frac{\mathbf{\$1000}}{\mathbf{0 \cdot 1}} = \mathbf{\$10{,}000.}$$