ECON 180

Introduction to Principles of Microeconomics and Financial Project Evaluation

Lecture 4: The Time Value of Money

September 15, 2021

Version 1.01 (Sep 19) Added Prescott & the WACC handout as recommended reading, Slide 3.

Required Reading and Viewing

- Khan Academy. (2011, June 8). Time value of money [Video File]. https://youtu.be/733mgqrzNKs
- Bastiat, F. (1850). The broken window. In *That which is seen, and that which is not seen* (Anonymous, Translator). http://bastiat.org/en/twisatwins.html#SECTION_G002
  - **You only need to read I. The Broken Window**
- If you prefer, you may read it in the original French: Bastiat, F. (1850). La vitre cassée. In *Ce qu'on voit et ce qu'on ne voit pas*. Retrieved from http://bastiat.org/fr/cqovecqonvp.html#vitre_cassee
  - You only need to read I. **La vitre cassée**

Recommended Reading & Viewing

- *Engineering Economics* 4.3 (MARR)
- Luymes, G. (2020, March 20). Caregiver leads the way in staving off burnout [Web Page]. Retrieved from https://vancouversun.com/news/local-news/caregiver-leads-the-way-in-staving-off-burnout
- Prescott, L. (1999). The minimum acceptable rate of return: engineering economic theory and practice [Master's Thesis]. https://era.library.ualberta.ca/items/05101c1f-f90f-471e-b254-bdfbfbdb323b
  - **A rare, detailed look at how the MARR is ccalculated in practice.**
- The Leukemia & Lymphoma Society of Canada. (2020, June 8). Survivor and Caregiver Burnout [Video File]. Retrieved from https://youtu.be/yyaauIoZCVc
- Willmore, C. (2021). Alex and their WACC [Handout]. (On Brightspace.)

Sources

- Bell, J. (2020, September 1). More than two dozen windows broken at James Bay school in recent weeks [Web Page]. https://www.timescolonist.com/more-than-two-dozen-windows-broken-at-james-bay-school-in-recent-weeks-1.24196102
- Haug, J. R. (1967). Education in Engineering Economics: The Consulting Engineer's Viewpoint. *IEEE Transactions on Power Apparatus and Systems*, PAS-86(12), 1497-1499. Retrieved from https://ieeexplore-ieee-org.ezproxy.library.uvic.ca/document/4073230

Optional Reading: Opportunity Cost

- Green, D. (1894). Pain-Cost and Opportunity-Cost. *The Quarterly Journal of Economics, 8*(2), 218-229. Retrieved from https://www-jstor-org.ezproxy.library.uvic.ca/stable/1883711
- **The paper believed to be responsible for originating the term 'opportunity cost'. Still very readable and insightful, over a century later.**
- **If you're pressed for time but still want to read the original reasoning behind opportunity cost, I recommend starting with the second paragraph on page 222 ("That the exchange value of…") and reading until the end.**

Optional Reading: MARR and Big Pharma

- Chit, A., Chit, A., Papadimitropoulos, M., Krahn, M., Parker, J., & Grootendorst, P. (2015). The Opportunity Cost of Capital: Development of New Pharmaceuticals. *INQUIRY: The Journal of Health Care Organization, Provision, and Financing.*, 52, 1-5. Retrieved from https://doi.org/10.1177/0046958015584641
- **Goes into detail about how the authors believe pharmaceutical firms should choose their MARR (discount rate representing their opportunity costs).**

Optional Reading: Caregiver Burnout

- Lilly, M. B., Laporte, A. & Coyte, P. C. (2010). Do they care too much to work? The influence of caregiving intensity on the **labour force participation** of unpaid caregivers in Canada. *Journal of Health Economics*, 29(6), 895-903.Retrieved from https://doi-org.ezproxy.library.uvic.ca/10.1016/j.jhealeco.2010.08.007
- Lilly, M. B., Robinson, C. A., Holtzman, S. & Bottorff, J. L. (2011). Can we move beyond **burden and burnout** to support the health and wellness of family caregivers to persons with dementia? Evidence from British Columbia, Canada. *Health and Social Care in the Community*, 20(1), 103-112.Retrieved from https://doi-org.ezproxy.library.uvic.ca/10.1111/j.1365-2524.2011.01025.x
- Jacobs, J. C., Lilly, M. B., Ng, C. & Coyte, P. C. (2013). The fiscal impact of informal caregiving to home care recipients in Canada: How the intensity of care influences **costs and benefits to government**. *Social Science & Medicine*, 81, 102-109. Retrieved from https://doi-org.ezproxy.library.uvic.ca/10.1016/j.socscimed.2012.12.015

Relevant Solved Problems

- From Engineering Economics, 6th edition, Chapter 2
- General Intuition: Example 2.1

Learning Objectives

- Understand what interest is, and some of the fundamental determinants of interest: risk vs reward and opportunity cost.
- Understand the concept of the MARR in terms of opportunity cost and cost of borrowing.

An offer you can't refuse?

- The Iron Bank of Braavos offers to lend you 100,000 dollars today. In exchange, you or your heirs must pay the 100,000 dollars back ten years from now (or earlier).
- You are 100% sure the Iron Bank will have its due.
- The only 'catch' is that there is a non-refundable $10 processing fee to be paid up front.
- Would you take this deal?
- Why would anyone pay $100,010 dollars for $100,000 dollars?
- That is, why would anyone pay interest?

Image Source: Shire Post Mint

Above: Lack of interest

What is interest?

- The amount you must pay tomorrow in order to have money today. Often reported in % a year
- Example: Borrowing $5 today and agreeing to pay $6 on Tuesday – the $6 is $5 in **principal** + $1 in **interest**.
- If you borrow $100 today from a bank that charges 5% interest a year, you'll owe $105 a year from now.

(Source: http://www.kchodorow.com/blog/2014/06/10/i-will-gladly-write-a-test-tuesday-for-a-program-today/)

What determines interest?

- "Interest exists because the lender of money deprives [herself] of the satisfaction of immediate consumption"
- "[T]he amount of money available for lending is finite and therefore subject to the forces of supply and demand."

Other reasons

* Compensation for risk

* Administrative costs

These are especially important for payday loans! (More on this later.)

"The interest on borrowed money is usually obvious, but recognition of interest on money in hand is equally necessary since the owner has the alternative of lending the money for other use or using it [herself] for some productive purpose." — J.R. Haug

Risk vs Reward

- Future payments aren't a sure thing.
- Even someone not wishing to increase funds through lending may want to avoid losing them.
- Higher risk → a *risk premium* on interest rates.
- e.g. If Wimpy has a 50% chance of not paying back a $5 loan, a lender may charge him $10 on Tuesday for a fiver today, just to break even on average.
- Not always a bad thing – some people treat risky loans as lottery tickets: low chance of a high payout.
- E.g. junk bonds known to be junk bonds

Opportunity Cost

- Another thing influencing interest rates is what else could have been done with the money, if it hadn't been lent out.
- In most cases: lent out to someone else or invested.
- Even if a lender doesn't want to gain, if they don't want to lose, they'll charge a rate equal to at least their next best option.
- The default 'next-best' option: government bonds
- A bond is an IOU: pay me know, I promise to pay you with interest in the future.
- Usually very safe, but pay a low rate of interest
- Since they're always available and (nearly) risk-free, they tend to be a determinant of how low interest rates can get.
- Higher rates → less businesses are viable.
- This is why changes in bond rates make the news!

What do you give up by lending $100 today?

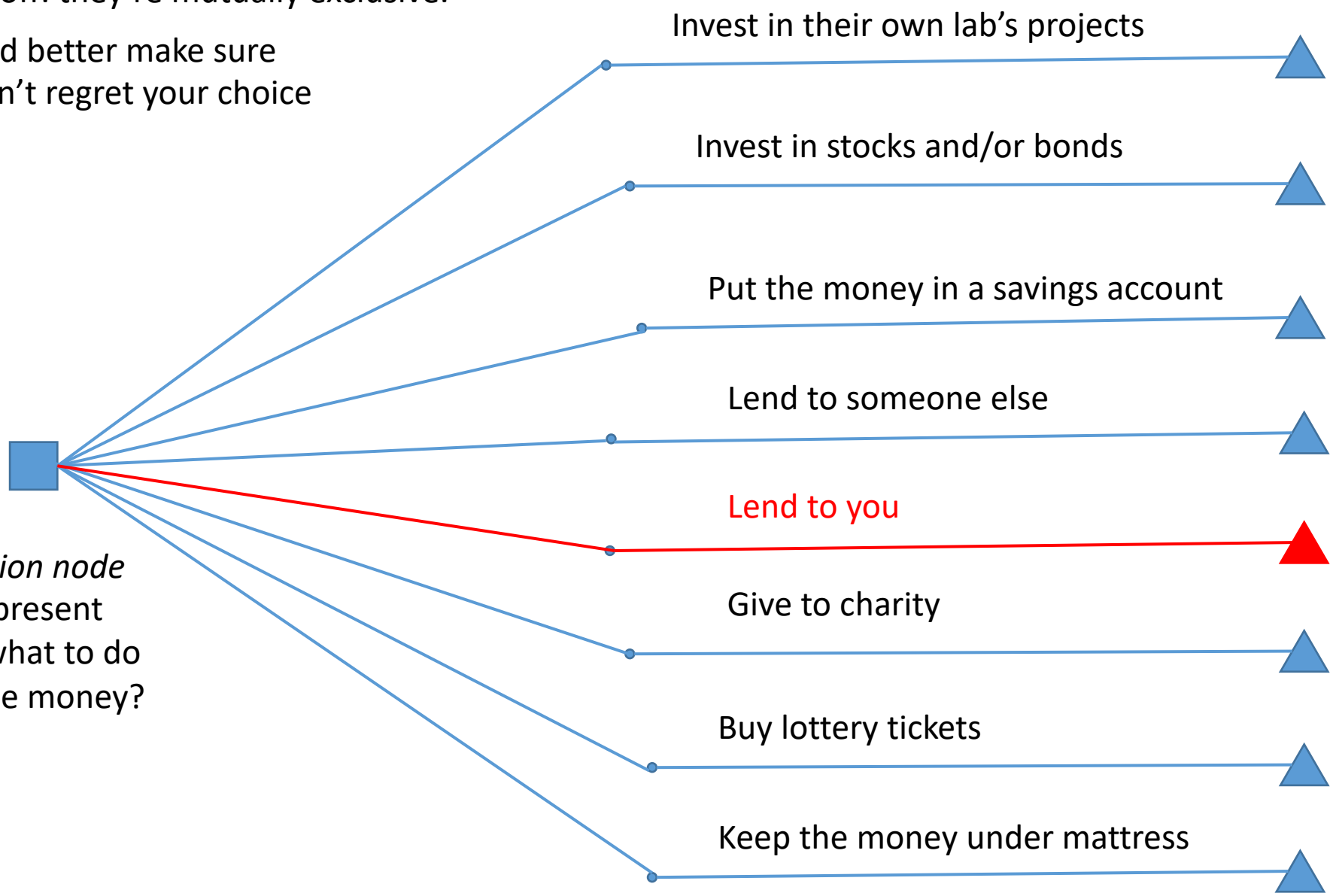
- You could be saving that money in a savings account (lending to a bank instead of a person): you're forgoing that interest income.
- You could be investing that money in (say) an indexed stock and bond fund: you're forgoing that investment income.
- You could be spending that money on entertainment: you're forgoing *utility* (satisfaction/well-being), which is worth at least what you're willing to pay for the entertainment.
- Maybe you don't have $100 and had to borrow it, in order to lend it: by lending the money, you're forgoing **not** having to pay the interest you've now incurred by borrowing.

El Psy Kongroo

- In the popular anime & visual novel, Stein's Gate, the protagonist, Okabe Rintaro, is given the ability to see different timelines, and (with effort) move between them.
- In one timeline they may have had coffee for breakfast, in another, tea and apple pie.
- What would it take to convince such a person to lend you money?
- Suppose, for simplicity, our version of Rintaro can see a bit of all possible timelines, and while they don't want to profit from money-lending, they also don't want to lose money by lending it to you.
- Their view of the timelines may look something like what follows:

Choose one timeline, and the others are locked off: they're mutually exclusive.

→ You'd better make sure you don't regret your choice



A *decision node* at the present time: what to do with the money?

To prevent regrets, you'd better make sure that what you GET from the timeline you choose is at least as good as from all the timelines you sacrifice.

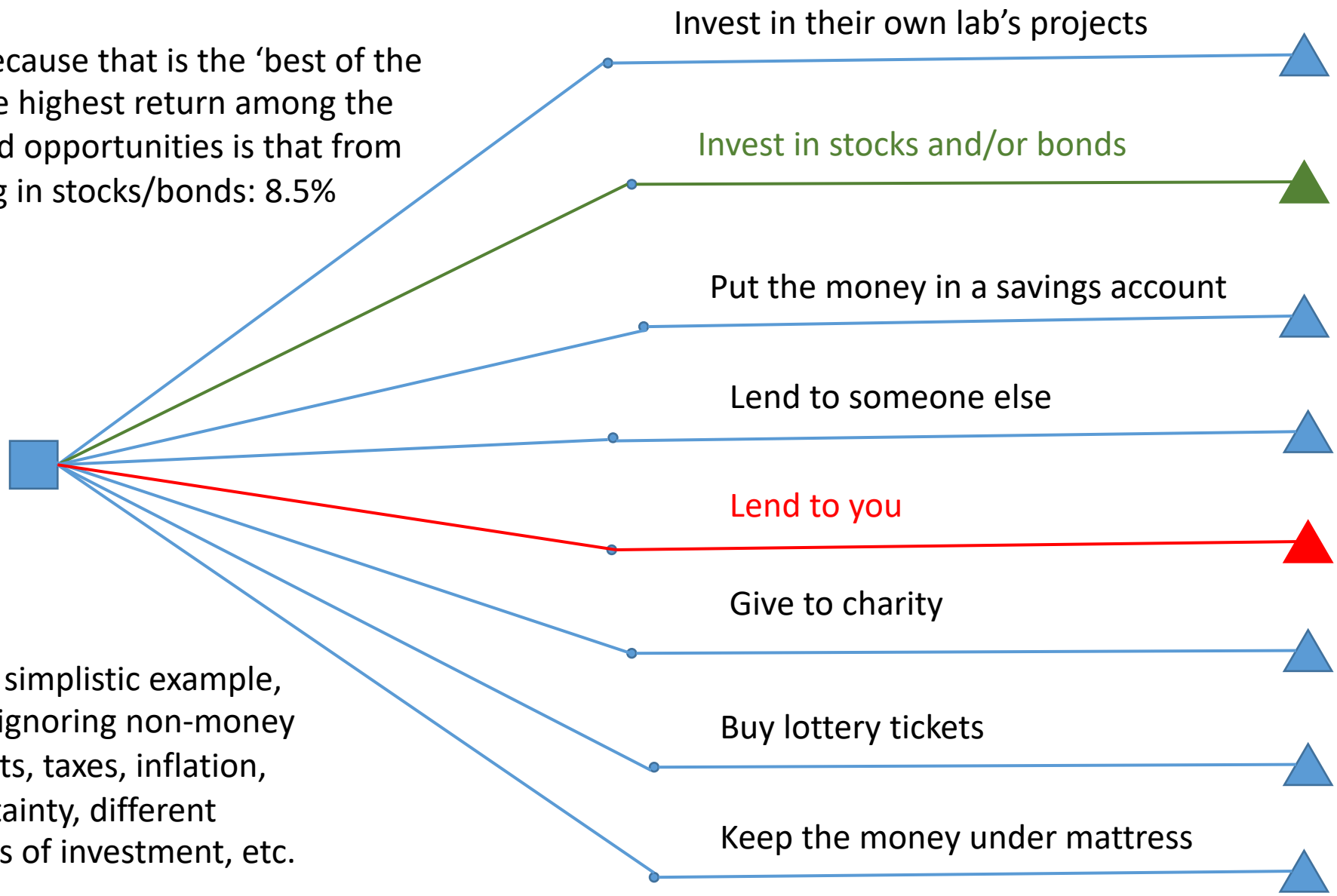
You want to avoid FOMO (Fear of Missing Out)

How do we make that comparison?

- Outcomes can be *very* different:
- Giving to charity gives you a ‘warm glow’ & benefits mostly others directly, buying lottery tickets has an element of chance, investing in your own lab has its own risks and rewards, stocks can boom or crash, lending to a friend can have social implications, etc.
- But, for engineering economics, we’ll mostly be dealing with things that can be expressed in terms of currency units: projects can be described by a sequence of cash flows – money going out, & money coming in.
- We can describe these outcomes in terms of the *growth rate* of money (a *rate of return*).
- Sometimes, this is the natural way of expressing it: if your savings account gives you 2% interest a year, money you put in grows at 2% per year.
- But even for projects that DON’T quote interest rates, we can convert a complicated cash flow into a value that can be reasonably compared to ‘% growth per time period’ values.
- (Either by finding an equivalent rate of return for those projects, or calculating a net present value evaluated at the rate of return you’re comparing it to. We’ll spend a LOT of course time on this.)

To avoid missing out, Rintaro would have to charge you 8.5% per year interest.

Why? Because that is the 'best of the rest': the highest return among the sacrificed opportunities is that from Investing in stocks/bonds: 8.5%



In this simplistic example, we're ignoring non-money benefits, taxes, inflation, uncertainty, different lengths of investment, etc.

FOMO and the MARR

- Any entity (individual, corporation, government, NGO, etc.) having to choose between different projects will face this kind of decision problem.
- There will be some ***minimum acceptable rate of return*** **(MARR)** that they will require from a project that they are considering.
- This will be equal to the return from the best alternative use of the same resources (that they know about).
- In Rintaro's case, this was the return from investing in stocks/bonds.
- In a corporation's case, it may be the return from their 'tried and true' projects, like creating an updated phone or a new edition of a sports video game.
- In all cases, the basic idea is that the decision-maker doesn't want to miss out by going for THAT project: it needs to be at least as good as what they (know they) are giving up.
- →Even someone who has **no intention of profiting from lending money** may still charge a positive interest rate on a loan, as compensation for giving up other opportunities.

Opportunity Cost

- Economists study the distribution of limited resources among unlimited needs and wants.
- This scarcity of resources compared to needs and desires is key:
- By using stuff for ONE purpose, we sacrifice using it for any other purpose.
- The opportunity cost of doing something is the next-best-use you could have put those resources to.
- The economic cost of an activity isn't just the direct financial cost measured by accountants, but also this indirect opportunity cost.
- You could have zero *economic profits* to an activity, but positive *accounting profits*: this just means the activity is just as good as the next best use of those same resources.

The Broken Window Fallacy (Bastiat, 1850)

- ”Breaking windows must be good for the economy! It’s cheap to do, and look at all the extra jobs it creates for glaziers and police!”
- Silly statement, but **why**, exactly?
- ”That which is seen”: more glaziers at work, glaziers getting extra income.
- **Accounting costs & revenues** are often seen.
- “That which is NOT seen:” no broken window → repair money is spent on other things (boots, shoes) & some ‘glaziers’ may be working at other productive & rewarding jobs.
- **Opportunity costs** are often unseen.
- Other things, too: impact on work & home life, feeling of (un)safety, diversion of police resources, etc.

This does not “boost the economy”…

…because this does not encourage the efficient use of scarce resources.

More than two dozen windows broken at James Bay school in recent weeks

Jeff Bell / Times Colonist
SEPTEMBER 1, 2020 03:55 PM

Doors of South Park Elementary School are boarded up after windows were broken. ADRIAN LAM, TIMES COLONIST

It diverts resources from (probably) more efficient uses…

…and in the end we’re likely back where we started (windows).

Food for thought: Can you think of any business, government & NGO initiatives that look like ‘broken windows’?

A simple world

- Your friend wants you to invest $100 in their home business.
- They'll pay you back in exactly two years.
- You're confident they're 100% good for it.
- Should you invest? Under what conditions?
- Simplifying assumption: The ONLY other possible use of this money is spending it on your fallback investment, which is always available.
- Fallback investment: For every $1 you spend, get $2, one year later.
- What's the opportunity cost of lending your friend the money?

Opportunity cost of the two-year loan

- Lend to your friend: $100 goes away for 2 years, then comes back (possibly with interest, or other ‘extras’).
- Suppose you DON’T lend to your friend.
- Then you put the $100 in the only other possible use: fallback investment.
- Now to one year from now: $100 becomes $200, put back in.
- One year from now to two years from now: $200 becomes $400.
- Whatever your friend pays you back, it needs to be *at least* as good as getting $400, two years from now.
- (Maybe the $200 principal plus a two-week camping trip for you two?)

A minimum acceptable return

- The lost opportunity from lending $100 for 2 years was investing it for 2 years, & getting $400 at the end of it.
- (Lose $100 today in both cases.)
- If you want to break even, your opportunity cost needs to be covered: you need to be *at least as well off* with a project, as without it.
- Your minimum acceptable return on the resources you relinquish is what they would have brought you in the next best use.
- Here: When your friend pays you back, it needs to feel at least as good as getting $400 two years from now.

The minimum acceptable RATE of return (MARR)

- We phrased the minimum acceptable return in $ in 2 years…
- …but that's awfully specific.
- Our fallback investment turns $1 today into $2 a year later.
- →Our fallback investment has a *rate of return* of 100%:
- $1 x (1 + 100%) = $2
- Since we can always get 100%/year from this fallback project…
- The minimum acceptable rate of return on any other projects we consider is 100% a year.
- Otherwise, we're better off with our fallback.

(OPTIONAL) Case Study: Informal Care

- The material below is *optional*, but it provides insight into opportunity costs (and implicitly, necessary rates of return).
- Informal/unpaid care of sick and elderly family members is ‘free’ in the sense that caregivers aren’t paid a salary…
- …BUT there are very high costs in terms of lost opportunities & caregiver burnout.
- If a health authority plans to shift care from, say, the hospital to the community, measures should be put in place to make sure that the additional benefits are worth the additional costs…
- …and to protect the mental and physical health of caregivers.

Informal Care and why it matters

- Informal care: **unpaid** care provided to the (usually chronically) ill by friends and family. Can include medical and personal care, domestic tasks and social support.
- Often under-valued or considered 'free' in economic evaluations, but an accurate valuation is important for:
- Analysis of tech/policies that support carers, such as Roombas (robotic vacuum cleaners) or Paro (a therapeutic robot seal) http://www.parorobots.com
- Cost-effectiveness analysis of health interventions with a secondary impact on carers, such as Alzheimer's medication that is more/less difficult to administer.
- Appropriate assessment of policies that change access to the formal health care sector, such as increasing user fees or granting universal access. (The latter is more attractive if increased health care costs are countered with reduced carer burden.)

Opportunity Costs

- Labour/Care trade-off: hours spent on care are hours not available for formal work, or for training for formal work (education).
- Can be measured as forgone wages, but this values care by high earners more than by low earners. Also, care can take place during 'leisure' time, and wages will not always be the marginal value of time.
- Care/Well-Being trade-off: large amounts of informal care can lead to 'burnout' in the carer, reducing quality of life, health status and quality/amount of future care.
- How large is 'large'? One problem: friends and family often care for each other even outside of the context of illness.
- Hours of informal care can be measured as time spent on caregiving over and above what would have been spent in the absence of illness.
- Problem: Not always easy to separate the 'extra', e.g. in long-term couples and housework, or when living arrangements change dramatically due to illness (since this leaves the carer with no base frame of reference).

Caregiver Burdens

- Objective burden of time spent, and subjective burden of caregiver burnout. (*Similar to QALY components, and modified QALY have been used to measure caregiver quality-of-life*.)
- Family members caring for seniors face worse health, injury, depression, anxiety, fatigue, money troubles and job loss.
- Lilly et al. (2012) identified two main themes when they asked BC dementia caregivers about their burdens (more on these later):
- "Forgotten: abandoned to care alone and indefinitely."
- "Unrealistic expectations."
- Burnout: the point when caregivers are 'depleted from caring' from physical and emotional exhaustion. Care recipients are most likely to transition to institutionalization after burnout (for more than one reason, as we'll see below)

The Work/Care Decision

- Individuals must choose:
  - Whether to care (Caregiver?)
  - How much to care (Primary or Secondary?)
  - Whether to work (Labour Force Participation, LFP)
  - How much to work (Reduced hours?)
- Some endogeneity: those already in the LF have high labour market opportunity costs, and those not in LF may self-select into care.
- According to a 2010 Canadian study, the main impact of caregiving on labour supply is through labour force participation, not reduced hours. Primary caregiving has this effect, secondary caregiving does not.

Forgotten: Abandoned to Care

- One of two major themes found in a qualitative analysis of BC caregivers by Lilly et al. (2012)
- Caregivers were taken for granted. Asking for help led to 'sorry, we're too busy' or 'you don't satisfy our rationing rules'.
- "As long as family members will keep looking after the person, the health care system will allow it to keep happening. It doesn't matter what is going on. As long as you keep doing it, they let you."
- For dementia patients, continuity of care is critical. Constant turnover of formal home care staff imposed unrecognized costs.
- "Not only are they overworked, but they get moved around all the time and you can't get to know anyone."

Ultimatums and Perverse Results (BC)

- Inflexible and limited caregiver respite leads to burnout. In one BC case, respite time was not enough to allow the caregiver to leave the house – she moved to another room to be alone.
- This leads to ultimatums – and they work, since they set off 'red flags' in community care planning algorithms, notably the 'Residential Assessment Instrument'. With flags triggered, the caregiver and recipient qualify for priority treatment.
- Ultimatum: "I just had to say 'She either goes into care, or you're going to look after her someway, because I can't."
- RAI Flag 1: "A caregiver is unable to continue in caring activities – for example, a decline in the health of the caregiver makes it difficult to continue."
- RAI Flag 2: "The primary caregiver **expresses** feelings of distress, anger or depression." (Emphasis mine.)

Cost-saving leads to extra costs (Lilly et al., 2012)

- "Caregivers can extract services only when they are at immediate risk of becoming patients themselves."
- "[R]ather than offering costly care *for* these individuals after they become patients of the system, we should re-orient our view to care *about* them preventively as partners in care provision."
- 2013 study: lower Labour Force Participation by **primary** caregivers costs the Canadian government $641 million a year in forgone income tax and extra social subsidies. By contrast, **secondary** caregivers (<5 hours/week) generate a net benefit to government of $4.4 billion a year.
- Partial explanation: counter-intuitively, formal and informal care are *complements*, not *substitutes*. Benefit to government falls as level of informal care rises, since level of formal care rises with it.