# NPV, IRR, AND CAPITAL INVESTMENT DECISIONS

**FIN 360: PRINCIPLES OF FINANCIAL MANAGEMENT**
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# RELEVANT CASH FLOWS

Recall the **capital budgeting** decision is the process of analyzing, planning, justifying, and deciding on large capital expenditures, or making **capital investment** decisions. Such decisions include investing in long term projects, R&D, building factories, acquiring other businesses, and purchasing other fixed assets.

To evaluate a capital budgeting decision, managers must consider the **relevant cash flows** for the project, or all of a firm's future cash flows that come about as a direct consequence of the project. Such relevant cash flows are referred to as the **incremental cash flows** of the project.

> ☆ **Incremental cash flows** for project evaluation consist of *any and all* changes in the firm's future cash flows that are a direct consequence of taking the project. Any cash flow that exists regardless of whether or not the project is undertaken is <u>not</u> relevant to evaluating a project.

The **stand-alone principle** is the assumption that evaluation of the project is based on these incremental cash flows alone, treating the project as a "mini firm" with its own income and expenses. We will determine whether purchasing this "mini firm" pays off.

## IDENTIFYING RELEVANT CASH FLOWS

Given an understanding that *incremental* cash flows are relevant in project evaluation, we consider a number of costs and circumstances that warrant further examination. The table below highlights some examples.

*Figure 1: Identifying Incremental Cash Flows*

| Example | Definition | Incremental Cash Flow? |
|---|---|---|
| **Taxes** | Taxes paid on the cash flows generated by the project. | Yes |
| **Opportunity Costs** | The most valuable alternative given up if a particular project is chosen. | Yes |
| **Sunk Costs** | A cost already incurred that cannot be "undone." | No |
| **Side Effects** | For example, **erosion**, whereby the cash flows of a new project come at the expense of existing projects. Alternatively, **synergies** whereby the cash flows of a new project *increase* cash flows of existing projects. | Yes |
| **Net Working Capital** | Changes in current assets and current liabilities (i.e., purchasing inventories on account) as a result of taking on a project. | Yes |
| **Financing Costs** | Debt incurred to pursue the project. Mixture of debt and equity financing. | No |

**EXAMPLE:** Casino and hotel operator MGM Resorts International hires a consultant to make a recommendation on whether they should build a new casino on the Las Vegas strip. They own a large parking structure that they acquired a decade ago for $20 million (which now has a market value of $30 million). They would build on this location. If they build the new casino, it may pull patrons away from the casinos it currently owns, including the Grand, Luxor, and Excalibur. The firm will issue bonds (or borrow) to pay for the building cost, thus incurring new interest payments. Lastly, they will simultaneously increase the amount of cash they have on hand and realize increases in A/R associated with the project. They will incur a 21% tax on project earnings. Fill in the table below:

| Example | Explanation | Incremental Cash Flow? |
|---|---|---|
| **Taxes** | | |
| **Opportunity Costs** | | |
| **Sunk Costs** | | |

| | | |
|---|---|---|
| **Side Effects** | | |
| **Net Working Capital** | | |
| **Financing Costs** | | |

*Relevant cash flows can be determined by looking at the difference between the firm's cash flows with and without the project.*

## PRO FORMA FINANCIAL STATEMENTS

Recall **pro forma** financial statements are financial statements that forecast future years' operations and help us calculate and visualize a project's incremental cash flows.

**PRACTICE:** Whole Foods Markets wants to develop a new beverage that has all necessary nutrients for daily life. It expects that it can sell 50,000 cans per year at a price of $4 each (while each can only costs $2.50 to produce). Given health fads tend to come and go quickly, this product has a three-year useful life. To produce this drink, they will need to purchase $90,000 in manufacturing equipment, which will straight-line depreciate to zero after three years. Fixed costs of the project, such as rent and insuring a facility, are $17,430 per year. Whole Foods will need to "invest" $20,000 in NWC, and the tax rate is 21%.

**SOLUTION:** First, let's build the pro forma income statement:

| | Year 0 | Year 1 | Year 2 | Year 3 |
|---|---|---|---|---|
| Sales (50,000 cans at $4) | | $200,000 | $200,000 | $200,000 |
| Variable Costs ($2.50/can) | | 125,000 | 125,000 | 125,000 |
| Fixed Costs | | 17,430 | 17,430 | 17,430 |
| Depreciation ($90k/3) | | 30,000 | 30,000 | 30,000 |
| EBIT | | $27,570 | $27,570 | $27,570 |
| Taxes (21%) | | 5,790 | 5,790 | 5,790 |
| Net Income | | $21,780 | $21,780 | $21,780 |

Notice there is no deduction for interest expense in the above statements. It is not considered an incremental cash flow.

[4]

Recalling our formula for operating cash flows, we determine this project $p$'s operating cash flow as:

$$Cash\ Flow_p = OCF_p - \Delta NWC_p - Capital\ Spending_p$$

where

$$OCF_p = EBIT_p + Dep_p - Taxes_p$$

From our values above, the operating cash flows $OCF_p$ in years 1 through 3 are:

$$OCF_p = EBIT_p + Dep_p - Taxes_p = \$27,570 + \$30,000 - \$5,790 = \$51,780$$

And we obtain the annual cash flows for the project in each year by filling out the table below:

|  | Year 0 | Year 1 | Year 2 | Year 3 |
| --- | --- | --- | --- | --- |
| OCF |  | $51,780 | $51,780 | $51,780 |
| ΔNWC | -$20,000 |  |  | +$20,000 |
| Capital Spending | -$90,000 |  |  |  |
| Total Project Cash Flow | -$110,000 | $51,780 | $51,780 | $71,780 |

> ℹ️ **Net Working Capital Recovery** occurs at the end of the project, after the cash flows wind down. For example, at the beginning of the project, the firm "invests" in its NWC (↑NWC: a cash *outflow*) by increasing inventories and accounts receivable (to cover its project's sales on credit). Payables may increase as well, but the firm will need to supply the balance.
>
> As a project winds down, its inventories are sold, receivables are collected, and payables and bills associated with the project are paid, freeing up the original investment in working capital.

Thus, we observe that this project has a cost (including investment in NWC) of $110,000 and is expected to produce cash flows of $51,780, $51,780, and $71,780 over the next three years.

> **?** How might we determine whether or not the company should pursue this project given what we know about its costs and cash flows?

## DEPRECIATION TAX SHIELD

The **depreciation tax shield** is the tax saving resulting from the depreciation deduction prior to paying income tax, given the expense (although it is *non-cash*) reduces the amount the firm needs to pay taxes on:

$$Depreciation\ Tax\ Shield = Depreciation\ Expense \times Tax\ Rate$$

$$Depreciation\ Tax\ Shield = 30,000 \times 0.21 = \$6,300$$

Notice in the previous example, in Year 1:

|  | Year 1: **with** tax shield | Year 1: **without** tax shield |
|---|---|---|
| Sales (50,000 cans at $4) | $200,000 | $200,000 |
| Variable Costs ($2.50/can) | 125,000 | 125,000 |
| Fixed Cost | 17,430 | 17,430 |
| Depreciation ($90k/3) | 30,000 | |
| EBIT | $27,570 | $57,570 |
| Taxes (21%) | 5,790 | 12,090 |
| Net Income | $21,780 | $45,480 |

$$OCF_{with\ tax\ shield} = EBIT + Dep - Taxes = 27,570 + 30,000 - 5,790 = 51,780$$

$$OCF_{without\ tax\ shield} = EBIT + Dep - Taxes = 57,570 + 0 - 12,090 = 45,480$$

The difference between the OCF with and without the tax shield is 51,780 - 45,480 = 6,300.

**Salvage value** is the amount of the equipment a firm purchased for a project that can be recovered at the end of the project if the equipment is sold. For example, assume in our example that the equipment used to produce the drinks could be sold for $10,000 (after taxes have been collected on the gain) at the conclusion of the project in 3 years, the project's cash flows become:

|  | Year 0 | Year 1 | Year 2 | Year 3 |
|---|---|---|---|---|
| OCF |  | $51,780 | $51,780 | $51,780 |
| ΔNWC | -$20,000 |  |  | +$20,000 |
| Capital Spending | -$90,000 |  |  |  |
| Aftertax Salvage Value |  |  |  | +$10,000 |
| Total Project Cash Flow | -$110,000 | $51,780 | $51,780 | $81,780 |

# EVALUATING INVESTMENTS: NPV, IRR, AND MORE

We've now identified the appropriate and relevant cash flows associated with a firm's projects. Next, we consider how we might *evaluate* these cash flows. Is a project's cash flows worth its costs? We will consider 5 techniques:

1. Net Present Value (NPV)
2. Internal Rate of Return (IRR)
3. Payback Period
4. Discounted Payback Period
5. Profitability Index

## *NET PRESENT VALUE (NPV)*

The **Net Present Value (NPV)** is the difference between an investment's market value and its cost. It is a measure of how much value is created or destroyed, taking into account the cash outflows and inflows.

> ⭐ Capital budgeting projects and investments with a *positive NPV should be accepted* and undertaken by the firm. Capital budgeting projects and investments with a *negative NPV should be rejected* by the firm.

To compute a project's NPV, we find the present value of the incremental cash flows and compare them to the initial cost of the project.

**PRACTICE:** Given the timeline below, determine the NPV of the project. Should the firm undertake such a project? Assume these cash flows are discounted at 15% given the riskiness of the project.

| Time | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Initial Cost | -$30 | | | | | | | | |
| Incremental CF | | $6 | $6 | $6 | $6 | $6 | $6 | $6 | $6 |
| Salvage Value | | | | | | | | | $2 |
| Net Cash Flow | -$30 | $6 | $6 | $6 | $6 | $6 | $6 | $6 | $8 |

**SOLUTION:**

$$NPV = PV \ of \ Incremental \ CF - Initial \ Cost$$

$$NPV = \left(\frac{6}{(1.15)^1} + \frac{6}{(1.15)^2} + \frac{6}{(1.15)^3} + \frac{6}{(1.15)^4} + \frac{6}{(1.15)^5} + \frac{6}{(1.15)^6} + \frac{6}{(1.15)^7} + \frac{8}{(1.15)^8}\right) - 30$$

$$NPV = -\$2.422$$

In our calculator:

| **Keystrokes** | **Explanation** |
|------|------|
| **CF** | The "cash flow" key, **CFo=** appears on the screen |
| **2ND** **CLR WORK** | "Clear worksheet" containing all cash flows (above **CE|C** key) |
| **CFo = -30** **Enter** **↓** | Cash flow at time 0: -$30, the initial cost |
| **C01 = 6** **Enter** **↓** | Cash flow at time 1: $6, a cash inflow |
| **F01 = 7** **Enter** **↓** | Frequency of the $6 cash flow is 7 times |
| **C02 = 8** **Enter** **↓** | The remaining cash flow is 8, which includes the salvage value |
| **F02 = 1** **Enter** **↓** | Frequency of the $8 cash flow is once |
| **NPV** | "Net Present Value" button |
| **I = 15** **Enter** **↓** | The discount rate |
| **CPT** **NPV** | Compute the "Net *Present* Value" = **-$2.422** |

**INTERPRETATION:** Here, *sign matters*, and cash flows need to be properly identified as positive (inflows for the firm) or negative (capital expenditures or costs by the firm). Given the project would have a *net* present value of -$2.422, the positive cash flows it yields aren't enough to offset its costs. This is only an estimate! Firms *forecast* the cash flows. Realized cash flows for projects can vary substantially from what the firm projected, causing seemingly positive NPV projects to result in a net loss for the firm.

**PRACTICE:** What is the NPV of the Whole Foods example from above, assuming a discount rate of 10%, payments at the end of the periods, and an after-tax salvage value of $10,000? Should Whole Foods accept or reject the project?

**SOLUTION:** Given the cash flows:

| 0 | 1 | 2 | 3 |
|---|---|---|---|
| -$110,000 | $51,780 | $51,780 | $81,780 |

We plug in

| CFo | CF1 | CF2 | CF3 |
|---|---|---|---|
| -$110,000 | $51,780 | $51,780 | $81,780 |

With I = 10%, **CPT** **NPV = $41,308.64.**

**INTERPRETATION:** Given this project has a NPV > 0, it should be accepted. We assume those forecast cash flows will be realized and that 10% is the appropriate discount rate.

Keep in mind additional applications for the NPV. For example, suppose a firm is thinking about overhauling its software systems (a $500,000 investment) that would result in cost savings of $100,000 per year. While the $100,000 per year isn't necessarily a new source of revenue (and sales won't increase), the firm can still consider $100,000 per year an incremental cash flow and use NPV to determine whether the cost of upgrading their software is worth it.

## *INTERNAL RATE OF RETURN (IRR)*

The **Internal Rate of Return (IRR)** is the discount rate that makes the NPV of an investment zero. The rate is "internal" to the project or investment itself.

Suppose you invest $100 and earn $10 on that investment over a year. Your IRR = 10%. Whether that was a good investment depends on what your required return was, or what you wanted to get out of that investment given the investment's level of risk. If the investment was extraordinarily

risky, you might have wanted to earn 25% for taking the bet. But if it was very safe, you might be content to accept the 10%.

> ☆ Capital budgeting projects and investments with an *IRR more than a required rate of return should be accepted* and undertaken by the firm. Capital budgeting projects and investments with an *IRR below a required rate of return should be rejected* by the firm. However, the IRR is subject to certain limitations.

**PRACTICE:** What is the IRR of the Whole Foods example from above, assuming payments at the end of the periods, and an after-tax salvage value of $10,000? Should Whole Foods accept or reject the project if, given the project's riskiness, management wants to achieve a 10% rate of return?

**SOLUTION:** Given the cash flows:

| 0 | 1 | 2 | 3 |
|---|---|---|---|
| -$110,000 | $51,780 | $51,780 | $81,780 |

The IRR can be found as:

$$NPV = 0 = -110,000 + \frac{51780}{(1+IRR)^1} + \frac{51780}{(1+IRR)^2} + \frac{81780}{(1+IRR)^3}$$

which generally can only be found with trial and error or with a calculator:

| CFo | CF1 | CF2 | CF3 |
|---|---|---|---|
| -$110,000 | $51,780 | $51,780 | $81,780 |

Then press $\boxed{\text{IRR}}$ (above the $\boxed{\text{PMT}}$ key) $\boxed{\text{CPT}}$ = **28.616%**

**INTERPRETATION:** Given this project has a IRR = 28.616% > Required Return = 10%, it should be accepted. We assume those forecast cash flows will be realized and that 10% is the appropriate discount rate given the project's risk.

> **?** Do the NPV and IRR rules always reach the same conclusion? *Yes* with three conditions:
>
> 1. The "required return" you compare your IRR to is the discount rate you choose in your NPV calculation (as it should always be).
> 2. The project has **conventional cash flows**: time zero is negative and the rest are positive.
> 3. Projects under evaluation are <u>not</u> **mutually exclusive**.

## *UNCONVENTIONAL CASH FLOWS*

**PRACTICE:** A gold mining operation requires an intitial investment to set up the site, but requires an investment in Year 2 to restore the mine. What is the IRR of the project with these cash flows?

| | |
|---|---|
| Year 0 | - $60 |
| Year 1 | + $155 |
| Year 2 | - $100 |

**SOLUTION:** We need to solve the following via trial-and-error:

$$NPV = 0 = -60 + \frac{155}{(1 + IRR)^1} + \frac{-100}{(1 + IRR)^2}$$

We get IRR = 25% or IRR = 33.33%:

$$NPV = 0 = -60 + \frac{155}{(1 + 0.25)^1} + \frac{-100}{(1 + 0.25)^2} \qquad \checkmark$$

$$NPV = 0 = -60 + \frac{155}{(1 + 0.3333)^1} + \frac{-100}{(1 + 0.3333)^2} \qquad \checkmark$$

**INTERPRETATION:** Both equations are true! But neither is unambiguously correct. If the firm chooses a required rate of return of 28%, they might *accept* by one computation and *reject* by another. Financial calculators and software might default to the lower IRR or randomly select one, but this isn't an adequate answer.

This is known as the **multiple IRR problem**. Fortunately, the NPV still works in these cases. Some problems don't even have an IRR. In your calculator, try an investment of $51 today, receiving $100 in one year, then investing another $50 in the second year.

## MUTUALLY EXCLUSIVE PROJECTS

Projects are **mutually exclusive** if pursuing one implies that the other cannot be taken. If, for example a retailer has land that they must decide to build either (1) a store or (2) a distribution center on, they must choose one or the other.

> ⚠️ The IRR <u>cannot</u> be used to compare mutually exclusive projects. Accept the project with the higher NPV.

**PRACTICE:** The Ford Motor Company wishes to reintroduce an electric version of one of its classic cars to its lineup, either the Model T or the Model A. Ford will only be able to produce one type of vehicle, not both. Whichever model it chooses, it will be for a limited time only (4 years). Calculate the IRR for each project.

| Incremental Cash Flows | | |
|---|---|---|
| Year | Model T | Model A |
| 0 | -$100 M | -$100 M |
| 1 | 50 M | 20 M |
| 2 | 40 M | 40 M |
| 3 | 40 M | 50 M |
| 4 | 30 M | 60 M |

**SOLUTION:** For the Model T:

| CFo | CF1 | CF2 | CF3 | CF4 | <CPT> IRR |
|---|---|---|---|---|---|
| -$100 | $50 | $40 | $40 | $30 | 24.00% |

For the Model A:

| CFo | CF1 | CF2 | CF3 | CF4 | <CPT> IRR |
|---|---|---|---|---|---|
| -$100 | $20 | $40 | $50 | $60 | 21.03% |

**INTERPRETATION:** Should Ford produce the Model T, given it has the higher IRR? Let's summarize the NPV of each project, assuming we choose required rates of return ranging from 0% to 25% (which you can verify in your calculator):

| Discount (Required) Rate | NPV Model T (IRR = 24%) | NPV Model A (IRR = 21.03%) |
|---|---|---|
| 0% | $60 | $70 |
| 5% | $43.13 | $47.88 |
| 10% | $29.06 | $29.79 |
| 15% | $17.18 | $14.82 |
| 20% | $7.06 | $2.31 |
| 25% | - $1.63 | - $8.22 |

Notice that the NPV is positive in all cases where the IRR is greater than the required rate of return. When the required rate of return is higher than the IRR, the NPV is negative. This is expected, since the IRR and NPV will reach the same conclusion for conventional cash flows.

However, if we choose a 5% discount rate for both projects, The Model A has the higher NPV. If we choose a 20% discount rate for both projects, The Model T has the higher NPV. The Model A may have greater cash flows, but it pays more slowly, leading to these differing conclusions given different discount rates. Therefore, *use the NPV to rank and select mutually exclusive projects.*

> **i** In general, don't use IRR to rank projects, even if seemingly independent.

## PAYBACK AND DISCOUNTED PAYBACK

The **payback period** is the amount of time required for an investment to generate cash sufficient to cover its costs. While a "back-of-the-envelope" or "quick" approach, this method is used by large firms for smaller day-to-day decisions. For example, the firm might require a two-year payback for projects under $10,000. Computation is relatively straightforward.

**PRACTICE:** A restaurant is interested in opening a new location. The cost will be $500k, with projected incremental cash flows of $150k, $250k, $350k, and *negative* $950k over the next few years. If the restaurant wants to be paid back in 4 years, will they accept this project?

**SOLUTION:** We need to see how long until the firm recovers its investment of $500,000. If it can do so under 4 years, the project should be accepted by this rule.

| Year | Cash Flow | Rolling Cash Flow |
|---|---|---|
| 0 | -500,000 | -500,000 |
| 1 | +150,000 | -500,000 + 150,000= -350,000 |
| 2 | +250,000 | -350,000 + 250,000= -100,000 |
| 3 | +350,000 | -100,000 + 350,000= 250,000 |

This project pays back sometime in year 2. In year 2, we only need $100,000, but the project earns $350,000. It's payback period is *2 + (100,000/350,000) = 2.28*. This is less than the 4 year requirement, and should be accepted by the payback period rule.

Notice the large negative cash flow of $950,000 in year 4 implies that this would be a *negative* NPV project that should be rejected. Use the payback period with caution!

The **discounted payback** technique is similar, but this method discounts the payments by a chosen discount rate:

**PRACTICE:** Assume the same series of cashflows in the above restaurant example, but with a 12% discount rate.

**SOLUTION:** Our table becomes:

| Year | Cash Flow | Present Value of Cash Flow | Rolling Cash Flow |
|---|---|---|---|
| 0 | -500,000 | | -500,000 |
| 1 | +150,000 | $150,000/(1.12)^1 = 133,928.57$ | -500,000 + 133,928.57= -366,071.42 |
| 2 | +250,000 | $250,000/(1.12)^2 = 199,298.47$ | -366,071.42 + 199,298.47= -166,772.95 |
| 3 | +350,000 | $350,000/(1.12)^3 = 249,123.09$ | -166,772.95 + 249,123.09= 82,350.14 |

This project pays back sometime in year 2. This is less than the 4 year requirement. Again, the project should be accepted under this rule, but note again that a large negative outflow in year 4 of the project implies we'd accept a negative NPV project.

Calculating fractional years is not commonly done in the discounted payback case as it is in the "undiscounted" payback case.

The payback method is simple to compute and intuitive. The discounted payback is an improvement in that it considers the time value of money, but both suffer from the assignment of an arbitrary cutoff period. And if discounted payback requires discounting, why not just use NPV? Both methods could result in accepting negative NPV projects.

☆ Capital budgeting projects and investments with a *payback or discounted payback period less than some chosen time period should be accepted* and undertaken by the firm. Capital budgeting projects and investments with a *payback or discounted payback period longer than the chosen time period should be rejected* by the firm. While intuitive, these methods may result in rejecting positive NPV projects (or accepting negative ones)

## *PROFITABILITY INDEX*

The **profitability index** or **benefit-cost ratio** is defined as the present value of a project's cash flows divided by the initial investment:

$$Profitability\ Index = \frac{Present\ Value\ of\ Project\ Cash\ Flows}{Initial\ Investment}$$

Notice the numerator is just the present value, not the *net present value*, of the cash flows. You can find the sum of the future cash flows by using the NPV function on your calculator while leaving CFo blank, just as you would find the present value of any series of cash flows.

If the profitability index is greater than 1, accept. Below 1, reject. For example, a profitability index equal to 1.2 means the project creates $1.20 for every $1 invested. A profitability index equal to 0.8 means the project creates $0.80 for every dollar invested.

☆ Capital budgeting projects and investments with a *profitability index greater than 1 should be accepted* and undertaken by the firm. Capital budgeting projects and investments with a *profitability index less than 1 should be rejected* by the firm. However, this method should not be used to rank projects (similar rationale as IRR).

## THE PRACTICE OF CAPITAL BUDGETING

The NPV is conceptually the best procedure to use. However, other methods are important to a financial manager. Being able to speak in terms of returns (IRR) or knowing when a project pays back (payback period and discounted payback period) is important.

Keep in mind that NPV is built on *estimates* or future sales, costs, and project lifespan. The hardest part of capital investing, then, is identifying projects and producing the forecasts (which here we take as a given!) Evaluating investments using multiple criteria becomes a must given the uncertainty inherent in projects.

The Excel file: *Investment Criteria* at www.josephfarizo.com/fin360.html provides examples and practice problems for each technique of evaluating investments.

*Figure 2: Summary of Investment Criteria Rules*

| Method | Summary | Percent Use* |
|---|---|---|
| **NPV** | Compare incremental cash flows to cost. Accept if positive, reject if negative, indifferent if zero. Heavily used. No serious cons. | 75% |
| **IRR** | The discount rate resulting in a zero NPV: accept (reject) if exceeding (below) required rate of return. Heavily used, but subject to multiple IRR, cannot be used for unconventional cash flows, and cannot be used for mutually exclusive projects. | 76% |
| **Payback Period** | Length of time until cash flows pay off costs. Accept if period is less than a chosen cutoff. Very intuitive, but it doesn't take into account risk or time value of money, and may reject positive NPV projects if they don't payback in time. | 57% |
| **Discounted Payback Period** | Length of time until cash flows pay off costs. Accept if period is less than a chosen cutoff. Intuitive, but one might as well compute the NPV if discounting cash flows anyway, and it may reject positive NPV projects if they don't pay back in time. | 29% |
| **Profitability Index** | The present value of incremental cash flows divided by initial cost. Accept if >1. May not be effective for mutually exclusive projects. | 12% |

*\*Percentage of CFOs who "always" or "almost always" use this capital budgeting valuation technique, from "The Theory and Practice of Corporate Finance: Evidence from the Field" by J.R. Graham and C.R. Harvey in the Journal of Financial Economics, 2001.*